Vol. 15 No. 4 AUGUST, 1952

TRANSACTIONS OF THE INSTITUTE OF WELDING

(See Title Page)

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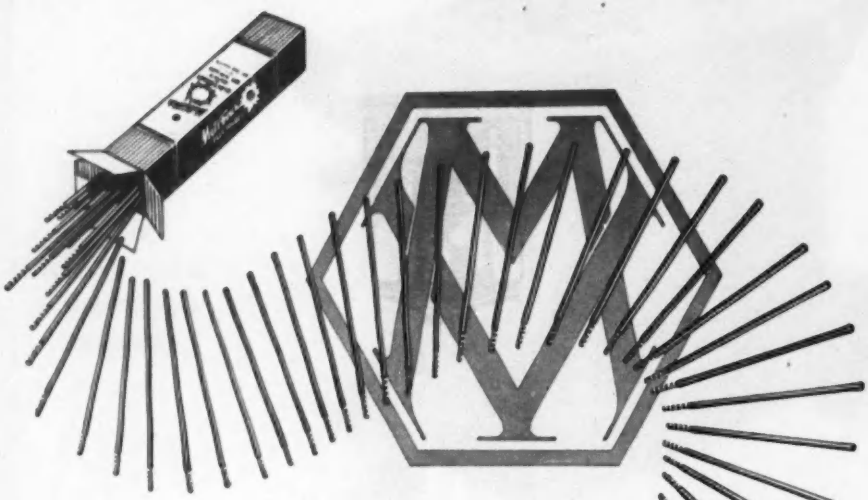

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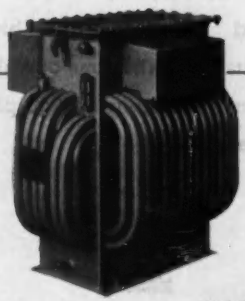

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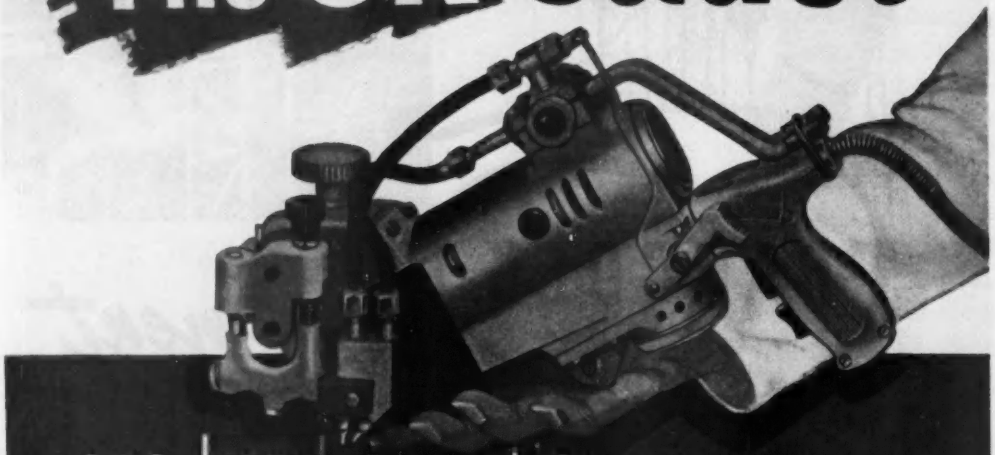

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Secretary: G. PARSLOE, M.A.

Honorary Editor: D. S. WATT, B.Sc., M.I.N.A.

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INSTITUTE NOTES AND NEWS

The New President.—Mr. A. Robert Jenkins, J.P., A.I.Mech.E., who assumed office as President at the Annual General Meeting on 22 July last, is deputy managing director of Robert Jenkins & Co. Ltd., of Rotherham. Born in 1908, Mr. Jenkins received his technical education in mechanical engineering at Sheffield University and as a pupil apprentice with W. H. Allen & Sons Ltd., of Bedford. In 1931 he joined the family business of Robert Jenkins & Co. Ltd. as plant maintenance engineer and after two years moved over to the production side to take charge of the works progress department, becoming works manager and a director in 1934. In 1946 he relinquished the post of works manager and became works director, responsible for the whole of the production and technical side of the Company, which today has shops covering an area of about six acres, a personnel of approximately 1,000 and an output of about 1,000 tons of fabricated products a month. Mr. Jenkins has travelled widely, visiting factories in Sweden and Germany before the war and being employed on a contract of his Company in Palestine. He undertook an extended visit to the United States to study the application of welding in 1947 and three years later made a second visit as a member of the British Specialist Productivity Team on welding.

Mr. Jenkins is a member of Council of the British Welding Research Association, has been President of the Rotherham Chamber of Commerce since 1950 and is a member of the Rotherham and District Employment Committee and of the Management Committee of the Sheffield Engineering Employers' Association. He has been associated with the Sheffield Branch of the Institute since its formation and is a past Chairman of the Branch and its present President.

Mr. H. B. Fergusson.—Mr. H. B. Fergusson, M.I.N.A., M.I.Mech.E., M.E.I. (Canada), the new Vice-President of the Institute, was educated as a mining engineer at the Royal School of Mines, Freiberg, Germany, and was later articled to his father, a member of the Institution of Civil Engineers. He became a full Member of the Canadian Society of Civil Engineers in October 1915.

For about six years Mr. Fergusson was a partner with

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The Institute of Welding is not responsible for and does not necessarily endorse statements made by Authors of Papers and contributors to the Discussions thereon.

Fergusson and Burr and afterwards with Colonel Du Cane, later head of Sir John Woolf-Barry & Partners, in consulting engineering offices in Vancouver, B.C., where in 1914 he joined the Royal Volunteer Engineers. Next year he led 750 skilled Canadian railway men to North Russia, where he was in charge of the construction of the Murmansk railway. In 1916 he became works manager of the Royal Ordnance Factory, Gretna, which employed a staff of 60,000. At the Armistice he was recommended by Lord Moulton for appointment as chief technical advisor to the British Military Governor at Cologne, where he stayed for about a year.

The next four years Mr. Fergusson spent in Spain as consulting engineer on hydro-electric plants and railway electrification projects. This was followed by five years in South America as chief agent for railway construction, during which time Mr. Fergusson was in charge of the construction of the main Trans-Andine highway from Cucuta to Bogota. Among a great variety of engineering projects, Mr. Fergusson was responsible for the heaviest section of Canadian railways, that of the Canadian National line between Yale and Hope on the Fraser river. For the past 15 years Mr. Fergusson has been a director of G. A. Harvey & Co. (London) Ltd.

Mr. H. B. Fergusson, new Vice-President

Mr. A. Robert Jenkins, new President

Indian Branch.—Encouraging news of the progress of the Indian Branch of the Institute is contained in the annual report of the Honorary Secretary, Rai Sahib N. G. Chatterji, delivered at the annual meeting of the Branch in Calcutta on 24 April last. During the year the Branch had held four meetings for the discussion of papers. Two of these were papers delivered to the Institute in London, namely "The Control of Distortion" by R. G. Braithwaite, and "Continuous Welded Structures, Abbey Works, Port Talbot" by W. S. Atkins—both, by the way, Sir William J. Larke Medal papers. A member of the Branch, Mr. J. H. Brantley, contributed a paper on "An all-welded Storage Tank".

Membership has slightly increased during the year and now stands at 107, while the statement of accounts shows a healthy financial position. The names of the new Officers for 1952/53 were printed in our last issue.

Appointments Register.—Industrial Corporate Members may like to be reminded that a register of members seeking posts as foremen, supervisors, representatives, managers, designers, etc., is maintained at the offices of the Institute.

Employers seeking staff (other than welders) are cordially invited to inform the Secretary of the Institute of their requirements, and so assist the Institute to expand this valuable service to its members.

Offers of Papers.—Members of the Institute who are willing to read papers at meetings of the Institute or of its Branches are invited to send particulars to the Secretary for submission to the Programme and Journal Committee not later than 30 September next. Where the complete text of the paper is not available, a short synopsis should be sent.

List of Welding Films.—A list of films on welding and allied processes has been compiled in the library of the Institute and is available to members, price 1s. 6d. (to non-members 2s. 6d.). The list contains the exhibition details and brief synopses of 73 films, which are classified under 13 subject headings. A simple reference system enables one to find the name and address of the suppliers of each film. The list

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E. Seymour-Semper, M.I.Mech.E.
J. Strong, M.A.

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Sir Charles Lillicrap, K.C.B., M.B.E.

Chairmen of Committees already appointed :
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Membership Committee—A. Hoddle.

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South Western—A. W. Wall, A.M.I.Struct.E.
West of Scotland—W. Heigh, M.I.Struct.E.
Wolverhampton—E. Flintham

NOTES AND NEWS—*continued from page 96.*

should be very useful to teachers of welding wishing to find appropriate films on any given aspect of the subject.

Handbook for Welded Structural Steelwork.—The Structural Welding Sub-Committee, which has charge of the new edition of the Handbook, met to consider suggestions of members and others toward the end of May. It is not, however, too late for those who wish to propose changes, improvements and additions to send them to the Secretary of the Institute.

In the meantime, copies of the fourth revised edition are still available, price 10s. per copy, post free. This edition incorporates a number of important corrections to the formulae on pages 111-118 of the fourth edition. Members who have the original fourth edition are invited to apply to the Secretary for copies of the corrected pages, which will be supplied post free.

Binding of Transactions.—Arrangements have been made for the binding of members' volumes of *Transactions* in black embossed leathercloth at a cost of 10s. 6d. each, plus 1s. for postage and packing. Members wishing to take advantage of this arrangement should forward parts, with index, to Mansell (Bookbinders) Ltd., 41 Britannia Row, Essex Road, London, N.1.

Reprints.—Reprints of the following papers in *Transactions* are available at the prices named : R. G. Braithwaite and D. J. Davies, "Welding in Bridgework and Allied Structures" (paper, illustrations and discussion reprinted from the December, 1949, and February, 1950, issues, price 2s. 6d.); R. Weck "An Account of M. Henri M. Schnadt's Ideas on the Strength of Materials and his Testing Methods" (reprinted from the April, 1950, issue, price 2s.).

Index to Transactions.—The index to Volume 14 (1951) of *Transactions* was published and bound in with the April, 1952, issue.

Conferences and Meetings.—Particulars of the following have been received at the Institute and may be had from the Secretary :—

Royal Netherlands Industries Fair—Utrecht, 2 to 11 September, 1952.

Centennial Congress of Engineering in the U.S.A.—Chicago, 3 to 13 September, 1952.

Associazione Italiana di Metallurgia, 6th National Convention—Genoa, 20-23 September, 1952.

The Institute of Metals, Symposium on Properties of Metallic Surfaces—London, 19 November, 1952.

Death of Mr. C. Cyril Hall.—We regret to record the death at the beginning of August of Mr. C. Cyril Hall, past Chairman of the Sheffield Branch of the Institute. An obituary notice will appear in our next issue.

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BOOK REVIEWS

Copper Development Association: *The Welding, Brazing and Soldering of Copper and its Alloys*. Pp. 188, illus, 8vo. (C.D.A. Publication No. 47, 1951.)

According to the list on p. 188 of this book the Copper Development Association has issued some 47 publications ranging from small brochures to well-bound books: it is to the latter class that the volume under review belongs. The title, though inelegant, is descriptive and the contents do not belie it, for the important subjects of welding, brazing and soldering are dealt with adequately whilst Chapter I is a useful discourse on the metallugical considerations of these processes. Chapter II describes the welding processes, gas, metal arc and carbon arc, so well, that it is a matter for regret that argon arc welding is not included here but is relegated to Chapter VIII, "Additional Jointing and Related Processes."

Some 60 pages are devoted to the welding of copper and copper alloys in Chapters III and IV, pages packed with excellent descriptive matter and sound metallurgical knowledge, which, in general, place the methods of welding and the relative weldabilities of the various alloys in their proper perspective. There is, however, one exception to this statement, for there is no mention of the application of A.C. argon arc welding to aluminium bronzes, a process quite well established. Bronze welding, that useful but misnamed process of jointing, is briefly but adequately described and illustrated. The importance of brazing, silver soldering, and soft soldering of copper and its alloys is fully expressed in the 40 pages on these subjects, and much useful information relating to processes, techniques, brazing and soldering alloys, etc., is given. Quite rightly, a brief note on copper as a brazing material for steel is included.

This volume, with its well-chosen bibliography of 153 items, will become a standard work of reference for all interested in joining copper and its alloys, and a text-book for students. The latter will not be misled by any serious mis-statements, for the book is singularly free from errors, but on occasion the loose phraseology is unfortunate. For example, on page 45, the statement is made that one of the disadvantages associated with arc welding tough pitch copper is "the oxide segregation which occurs on melting." The reviewer suggests that oxide segregation occurs during solidification, not melting. On p. 22 the ingenuous statement is made that the properties of temper hardening beryllium copper approach those of tool steel—a distant approach surely.

Of the 81 illustrations, by far the greater number are excellent, the photographs illustrating welding and brazing techniques being of particular value. Some of the photomicrographs, however, do not come up to the general standard; the oxide distribution in Fig. 17 is not typical of cold worked and annealed copper, for the network of oxide originally present in the casting is not completely broken down. The omission of the magnifications from all but one of the photomicrographs will be regretted by all metallurgists.

It is not unusual for the reviewer of a book to conclude with some remarks about its value in relation to the price. To do so here would be invidious, for this book, worth 25s. of anyone's money, can be obtained by *bona fide* applicants for the price of a postage stamp.

J. F. L.

Ship and Boat Builder Annual Review, 1952.

Ships of the smaller class covering everything from little patrol vessels to trawlers and minesweepers are of increasing interest to the welding engineer. Although there is not much about welding in *Ship and Boat Builder Annual Review*, 1952, this volume is a mine of information for everyone interested in the smaller ships and their machinery.

A comprehensive and well-illustrated article on "The Motor Coaster" is contributed by Commander A. C. Hardy, an authority on the subject. Mr. A. L. Cochrane writes on "Three Decades of Trawler Development," Mr. W. H. Dann on "Composite Construction" and there are also articles on sailing yachts, the state of the industry, sweeping the sea in little ships, and the progress of aluminium in shipbuilding.

Most useful in this volume are the series of references, such as directory of marine fittings, directory of yard equipment and materials, index to manufacturers and suppliers and lists of associations and builders at home and abroad.

D. S. W.

Shorter Notices.

Dollar Savings through Standards, a report just published here by the Productivity and Technical Co-operation Division of the American Mutual Security Agency, shows a sharp rise of the standards movement in the United States since the war. The report, which is described as "an attempt to compile a body of measurable proof in terms of dollars or percentages of net savings and specific economic benefits attributable to standardisation", covers 140 documented case studies, among which is one bearing on the use of welding symbols, one on the standardisation of welding rods and electrodes and one on standardisation of safe practice in electric and gas welding and cutting operations. (Obtainable from the American Embassy).

The Anglo-American Council on Productivity (21 Tothill Street, London, S.W.1.) has issued *Servicing the Moulder: a Review of Productivity in the Grey Ironfounding Industry*, the third of a series of short statements reviewing developments in industries from which productivity teams have gone to the United States.

OPENING OF FATIGUE TESTING LABORATORY

There was an excellent attendance of members and guests to witness what Sir William Larke, the President of the British Welding Research Association, called the crowning act of a great achievement on 23 June last, when the Lord President of the Council, Lord Woolton, opened the new fatigue testing laboratory at the Association's Research Station at Abington Hall.

The proceedings began with the annual general meeting of the Association at 12 noon and the formal opening of the south doors of the new laboratory at 1 o'clock. The party then passed through the laboratory and more than 250 took luncheon in a marquee. Sir William Larke presided and welcomed Lord Woolton and the other guests on behalf of the Association. Lord Woolton then proposed the toast of the British Welding Research Association, to which a response was made by Sir Charles Lillicrap, Chairman of the Council.

After luncheon the visitors scattered to inspect a very interesting exhibition of the researches now in hand, arranged by the staff of the Association in the various laboratories and buildings surrounding the Hall. The occasion was favoured with a dry and sunny day, which added to the enjoyment of the large and distinguished gathering.

The new laboratory gives an immediate impression of light and neatness and is of exceptional interest to welding specialists, because it embodies the principles of plastic design elaborated by Professor J. F. Baker. The architect is Mr. George Coles, F.R.I.B.A., and the consulting engineers acting in collaboration with Professor Baker are W. S. Atkins & Partners. The builders were David Chaston Ltd., the steelwork was supplied by The Fairfield Shipbuilding and Engineering Co. Ltd., and Dolby & Williamson acted as consulting engineers for the heating and electrical installation.

Including its office accommodation, the new laboratory has a floor area of 5,000 sq. ft. It is a steel structure with brick cladding. The outstanding feature of its equipment is a Losenhausen fatigue testing machine capable of 200 tons static load or 100 tons fluctuating load at speeds up to 600 cycles a minute. The cost of the improved facilities for fatigue testing, including the new laboratory, provided by the Association, has been £40,000.

INSTITUTE MEMBERSHIP

The following elections were made by Council on 11 June, 1952:—

Members. — E. S. Booth, M.Eng., A.M.I.E.E., A.M.I.Mech.E., Walton-on-Thames, Surrey; J. L. Hamilton, A.R.T.C., A.M.I.E.E., Coulsdon, Surrey; A. J. Hipperson, B.Sc. (transfer from Associate-Member), London, S.E.4; F. Ketley, Chapeltown, nr. Sheffield; A. J. Pluhar, Toronto, Canada; C. M. Wilcock, Grantham, Lincs.

Associate-Members.—C. Allinson (transfer from Associate), Halton, Leeds; A. S. Beedham, A.M.I.Mech.E., A.M.I.Prod. E., F.S.C., Whitley Bay, Northumberland; C. Blakeman, Tipton, Staffs; R. A. Blocksidge, Southall, Middlesex; T. L. Brown, Edinburgh, 5; R. R. Burns, Stockton-on-Tees; J. T. Duell, Luton, Beds; R. Elliott, Ashby, Scunthorpe; N. A. Forster, B.Sc., Cullercoats, Northumberland; R. Hargreaves, Moortown, Leeds; H. McDonald, G.I.Mech. E., Old Trafford, Manchester; R. S. Miller, Calcutta, India; L. Morse (transfer from Graduate), Cwmdu, Swansea; P. Rastall, B.Sc., A.I.M., Sale, Cheshire; L. J. Suffield, A.M.I.Mech.E., Barking, Essex; W. Townsend, Tipton, Staffs; J. Welch, Billingham-on-Tees.

Companions.—F. W. Arnold, Wingerworth, nr. Chesterfield; J. S. Billington, Clitheroe, Lancs; A. W. Crawley, Burnley, Lancs; P. F. Doran, Perivale, Middlesex; J. S. R. Jones, Stoke Bishop, Bristol; K. A. Peel, Sevenoaks, Kent; E. Wilson, Church, Lancs.

Graduates.—D. G. W. Claydon, G.I. Mech.E., Banbury, Oxon; N. Davies, Dudley, Worcs; A. R. Jackson, Sheffield, 7; K. R. Jastrzebski, B.Sc., Wolverhampton; D. E. Jones, B.Sc., Wolverhampton; L. W. Jones, S.I.Mech.E., Birmingham, 11; R. D. Kynnersley, Dudley, Worcs; C. R. Lunn, Dudley, Worcs; A. E. Newton, B.Sc., A.M.C.T., Widnes, Lancs; R. Paskin, Cullercoats, North Shields; J. L. Sanders, London, N.14; E. F. Sear, Porthleven, Cornwall; N. W. Taylor, Sedgley, Worcs; R. L. A. Wright, Lowestoft, Suffolk.

Associates.—A. E. Baker, Doncaster; H. Bateman, Bramley, Leeds; C. Binstead, Locksheath, Hants; P. T. Budd, Norwich, Norfolk; J. J. Donnelly, Auldhouse, Glasgow; T. J. Dulieu, London, E.16; R. H. C. Floyd, Bridgnorth, Shropshire; F. B. Goddard, London, S.W.12; F. W. Haimes, Nottingham; J. Hannah, Strathaven, Lanarkshire; G. Hogarth, Preston; M. C. Hughes, Huyton, nr. Liverpool; J. F. Hunt, Dagenham, Essex; R. W. Lovelock, Eastleigh, Hants; H. G. Machin, Darlington; G. Mackay, Walkden, nr. Manchester; R. C. Merman, Shiremoor, Northumberland; A. F. Newton, London, S.E.5; S. G. Parker, Winchester, Hants; D. A. Paveley, Aylestone, Leicester; G. A. Pearson, Sheffield, 9; A. R. Preston, Upper Gornal, Worcs; A. E. Rogers, Raunds, Northants; T. E. G. Seamer, Cumnor, Oxford; D. S. Shillito, Whitefield, Manchester; A. H. Symonds, Gorleston-on-Sea, Norfolk; T. A. Tindale, Newcastle-on-Tyne, 5; A. B. Tinsley, Harlescott, Shrewsbury; J. K. Ward, Bilston, Staffs; S. H. Weeks, Brislington, Bristol; H. Williams, Yeadon, nr. Leeds.

Student.—D. I. Robinson, Kidderminster, Worcs.

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Industrial Corporate Members, Class 2.—The Canadian Welding Society (Hon. Member), Toronto, Canada.

Industrial Corporate Members, Class 3.—"New Western," Leeds, 11.

INSTITUTE MEETINGS

The following is a list of meetings arranged for the months of September and October, 1952, so far as details are available at the time of going to press:—

4 Sept. **Tees-side Branch**
Works visit to Furness Shipyards, Hewerton Hill.

6 Sept. **Liverpool Branch**
Works visit to English Electric Co. at Kirkby and social visit to Southport.

23 Sept. **Leeds Branch**
Opening Address and paper by J. Berry.

25 Sept. **North London Branch**
"Welding in America" by F. Clark, M.B.E., H. E. Lardge and S. M. Reisser, B.Sc.(Eng.), A.M.I.C.E., M.I.Struct.E., (at Regent. St. Polytechnic).

26 Sept. **East of Scotland Branch**
Film night (at Edinburgh).

26 Sept. **South Western Branch.**
Dinner.

1 Oct. **Manchester Branch**
"Welding Developments in the Shipbuilding Industry" by J. W. Day.

1 Oct. **Preston Branch**
"Oxy-Acetylene as a Repair Medium" by E. Christie.

2 Oct. **Eastern Counties Branch**
"Tubular Structures" by E. McMinn (at Norwich).

2 Oct. **Tees-side Branch**
Argonarc film and lecture.

3 Oct. **Eastern Counties Branch**
To be arranged.

8 Oct. **Institute Meeting**
Presidential Address by A. Robert Jenkins, J.P., A.I.Mech.E., Inst. of Civil Engineers, 6.30.

9 Oct. **Tyneside Branch**
"Recent Developments in the Welding of Aluminium Alloys" by P. T. Houldcroft.

10 Oct. **South Western Branch**
"Design for Welding" by S. M. Reisser, B.Sc.(Eng.), A.M.I.C.E., M.I.Struct.E. (at Bristol).

14 Oct. **East Midlands Branch**
"The Design of Welds for Pressure Vessels" by E. J. Heeley, A.Met., F.I.M. (at Nottingham).

14 Oct. **Liverpool Branch**
"Recent Developments in Arc Welding Electrodes" by D. Young.

15 Oct. **Wolverhampton Branch**
"The Development of Metallic Arc Welding and Electrodes during the past half century" by E. Flintham.

15 Oct. **West of Scotland Branch**
"Fabrication of Jib for W.1400" by A. Scott.

16 Oct. **South London Branch**
"New Ideas on the Welding of Aluminium" by P. T. Houldcroft.

23 Oct. **Leeds Branch**
Ladies' Night and film show.

23 Oct. **North London Branch**
"New Arc Welding Developments" by Dr. H. G. Taylor, M.I.E.E., F.I.P. (at Slough).

24 Oct. **East of Scotland Branch**
"The Welding of Alloy Steels" by E. J. Mitchell, B.Sc., M.I.M., at Edinburgh.

29 Oct. **Institute Meeting**
"Modern Developments in the Industrial Application of Resistance Welding" by H. E. Dixon, M.Sc., A.I.M., Inst. of Civil Engineers, 6.30.

Latest Additions to the Library

As a supplement to the Library catalogue, this section of the *Transactions* contains particulars of books and pamphlets added to the Library during the third quarter of 1952. The books, pamphlets and periodicals specified are available on loan to members of the Institute.

Publications preceded by an asterisk are donations to the Library from authors or publishers; those preceded by a dagger are donated by the James F. Lincoln Arc Welding Foundation.

BOOKS AND PAMPHLETS

***ALGAR, S. M.**
What is it made of? Typescript, 5 pp. 1952. **(A method of identifying metals with special reference to the agricultural welder.)** Publishers: Rural Industries Bureau, 35, Camp Road, London, S.W.19.

***ALUMINIUM DEVELOPMENT ASSOCIATION**
The gas welding of aluminium. Illus. 2nd ed. revised. 1952. (*Information Bulletin No. 5.*) (Written in collaboration with the British Welding Research Association, this Bulletin replaces B.W.R.A.-T.I.) Publishers: Aluminium Development Association, 33, Grosvenor Street, London, W.1. Price: 2s.

***ANGLO-AMERICAN COUNCIL ON PRODUCTIVITY**
Productivity Team Report on iron and steel. Illus. 1952. Publishers: Anglo-American Council on Productivity, 21, Tothill Street, London, S.W.1. Price: 5s.

BAES, L.
Calcul des ossatures des constructions: détermination de la sollicitation des éléments constituant les ossatures. I.—Introduction. 2.—Eléments fondamentaux relatifs à la poutre droite. Illus. 552 pp. 1952. Publishers: Centre Belgo-Luxembourgeois d'Information de l'Acier, 154, Avenue Louise, Bruxelles. Price: 500 Belgian francs.

***BRITISH ENGINEERS' ASSOCIATION (INC.)**
Classified handbook of members. 1952. Publishers: British Engineers' Association (Inc.), 32, Victoria Street, London, S.W.1.

***BRITISH STANDARDS INSTITUTION**
1443:1952. Sizes of X-ray film and intensifying screens for medical and industrial use (excluding crystallography). Publishers: British Standards Institution, 24, Victoria Street, London, S.W.1. Price: 2s.

***BRITTON, S. C.**
The corrosion resistance of tin and tin alloys. 1952. Publishers: Tin Research Institute, Fraser Road, Greenford, Middlesex.

***CANADIAN WELDER**
Vol. 43, April, 1952, *to date*. Publishers: Canadian Welder, 365, Bannatyne Avenue, Winnipeg, Canada. Price: 1 dollar 25 cents.

DU RIETZ, K. D. and KOCH, H.
Praktisches Handbuch der Lichtbogenschweissung. Illus. 3rd ed. 1948. (A reprint of the 2nd ed. 1947.) Publishers: F. Vieweg & Sohn, Braunschweig. Price: DM 7.80.

***P. R. MALLORY & CO. INC.**
Resistance welding data book: theory and practice. Illus. 4th ed. 1952. Publishers: P. R. Mallory & Co. Inc., Indianapolis 6, Indiana, U.S.A. For sale at Johnson, Matthey & Co. Ltd., 73-83, Hatton Garden, London, E.C.1. Price: 3 dollars.

***NATIONAL PHYSICAL LABORATORY**
(a) Report for the years 1940-1945. (b) Report for the year 1951. (c) Units and standards of measurement employed at the National Physical Laboratory. III.—Electricity, current, voltage, resistance, power, energy, inductance, capacitance, frequency, etc. Publishers: H.M.S.O., York House, Kingsway, London, W.C.2. Price: (a) 5s.; (b) 3s.; (c) 9d.

***QUASI-ARC CO. LTD.**
Instruction book for electric arc welders. Illus. 1952. Publishers: Quasi-Arc Co. Ltd., Bilston, Staffs. Price: 2s. 6d.

SAHLING, B., and LATZIN, K.
Die Schweisstechnik des Bauingenieurs: Einführung in Entwurf, Berechnung, Herstellung und Untersuchung von Schweissverbindungen im Stahlbau unter Berücksichtigung der amtlichen Vorschriften. Illus. 2nd revised and enlarged ed. 1952. (This volume for the structural engineer deals with design, calculations, fabrication and testing of welded joints in structures with reference to standard specifications. There is a comprehensive bibliography.) Publishers: F. Vieweg & Sohn, Braunschweig. Price: DM. 19.20.

SCIENTIFIC FILM ASSOCIATION
(a) List of films for training industry. 2nd ed. 1952. **(b) List of distributors of industrial films.** 1952. Publishers: Scientific Film Association, 164, Shaftesbury Avenue, London, W.C.2. Price: (a) 7s. 6d.; (b) 3s. 6d.

***STRETTON, H. J.**
Automatic arc welding in industry. Applying automatic arc welding equipment. (Papers read to the North-Eastern Branch and to the Liverpool Branch of the Institute of Welding giving correct procedure for Fusarc welding with numerous applications.) Publishers: Fusarc Ltd., Team Valley, Gateshead-on-Tyne, 11.

TRADE CATALOGUES

FRED. C. ARCHER INC.
Blueweld lo-hydrogen electrode stabilizer. (Cabinet with temperature thermostatically controlled.) 1952. Address: 606, West Wisconsin Avenue, Milwaukee, Wisconsin.

BRITISH THOMSON-HOUSTON CO. LTD.
Electronic induction heaters: 10 kW and 25 kW output. Address: Rugby.

CARBORUNDUM CO. LTD.
Grinding wheel gradings. 1952. Address: Trafford Park, Manchester, 17.

DAVY AND UNITED ENGINEERING CO. LTD.
Heavy weldments (numerous examples of weldments for units). Welding manipulators (½, 1, 6 and 13-14 ton manipulators). Address: Park Iron Works, Sheffield, 4.

DELORO STELLITE LTD.
Hardfacing with Deloro Stellite. Address: Highlands Road, Shirley, Birmingham.

DELTA METAL CO. LTD.
"Delta" welding rods for gas welding. Address: Delta Works, Tunnel Avenue, East Greenwich, London, S.E.10.

DOWSON & MASON GAS PLANT CO. LTD.
Portable cover furnaces, carbottom furnaces, gas fired carbottom furnaces, furnaces for service to industry, all of which are suitable for stress relieving welded parts. Address: Alma Works, Levenshulme, Manchester, 19.

ELCONTROL LTD.
Elcontrol aids to production, which include process timers and weld timers. Industrial temperature control equipment. Address: 10, Wyndham Place, London, W.1.

ENFIELD ROLLING MILLS LTD.
Technical data on high conductivity copper base alloys used for resistance welding and electrical engineering applications. Address: Brimsdown, Enfield, Middlesex.

EUTALLOY & WELDING PROCESSES LTD.
Buyers' guide. Eutalloy carbon arc torch. Eutalloy electric welder. Eutalloy range of gas welding materials. Welding accessories. Address: Woodhall Court, Welwyn Garden City, Herts.

A SHIPYARD RE-ORGANIZATION FOR WELDED PRE-FABRICATED CONSTRUCTION

By CLEMENT STEPHENSON, A.M.I.N.A.

Paper read before the North Eastern (Tyneside) Branch of the Institute, 17 April, 1952

Introduction

THE increased adoption of electric welding into the shipbuilding industry in what we may call the "competitive thirties" was due to its main virtue—the saving of steel with the resultant reduced hull weight and corresponding increased deadweight, coupled with its added advantage of obtaining watertightness under all conditions of stress. The actual hull construction during this period was carried out in the main on the same lines as with the all-riveted method, namely, plate-by-plate erection, and welding was treated more as a convenience than as a new method of construction. The advent of the second world war, which brought to light the acute shortage of riveting labour and the subsequent postwar lack of recruitment into this trade, finally made the shipbuilder turn to welding as a new method of hull construction.

With this turn of events it was soon realized that, with welding as the main joining medium, the previous method of erection plate by plate and welding *in situ* was an inconvenient method of construction and it became increasingly necessary to study new constructional methods. Fanned by the efforts of the United States shipbuilding industry during the war the method of pre-fabrication in association with electric welding was developed and has been found both technically and economically to justify its adoption on a large scale.

The object of this paper is not to promote a discussion on the merits of pre-fabrication but, having adopted pre-fabrication as being an essential method of construction, to illustrate how the establishment of Messrs. William Doxford & Sons Ltd. approached the problem of plant re-organization to deal effectively and economically with it.

Old Yard and its Facilities

The arrangement of the establishment as it existed prior to 1951 consisted basically of two separate building yards known as the East Yard and the West Yard (Fig 1). These yards each had three building berths, the East Yard capable of building vessels up to 20,000 tons and the West Yard vessels of about 10,000 tons. Each yard had its attendant Platers' Shop, Frame Furnaces, Scrieve boards, Punching and Shearing Machines, Plate Rolls, etc. and was fed from a common stockyard.

The East Yard berths were served by an overhead crane gantry system, each berth being covered by nine 3-ton electric cranes, while the West Yard cranage consisted of the well-known system of 3-ton derrick cranes.

Re-organization

To embark upon a policy of the extensive use of structural welding with the existing plant combined with the old established ship constructional methods, namely, plate-by-plate erection, could not be economically justified. The principal outcome of pre-fabricated construction is the considerable reduction in the period of erection on the berth, and, under conditions where manpower was more or less limited, it was obvious that for a given steel tonnage output some of the existing building berths were surplus.

The output of the six berths under the existing conditions was in the region of 22,000 tons of steel per year, the average berth time in the East Yard being about 180 days and in the West Yard 235 days, and it was estimated that, with the adoption of pre-fabrication, this output could be maintained on three berths with slightly reduced man-power.

Efficient pre-fabricated welded construction requires the following essentials:—

(a) Large under-cover area to provide ideal welding conditions.

(b) Large area for pre-berth storage of sub-assemblies.

(c) Simplified flow of material from stockyard routed via platers' shops, pre-fab. shed, to storage area and berth with the minimum of handling.

In a yard in which development in depth was impossible and where the contour is such that there is a fall of some 72 feet from the boundary to the head of the building berths, it was soon realized that a lay-out of the required "ideal" type was impossible and, due to these unique conditions of declivity, we had to turn to the West Yard area for development.

Pursuing the policy of maintaining production on three berths instead of six, the three West Yard berths were considered surplus and these, together with the area covered by the attendant platers' shop, scrieve boards, furnaces, beam machines etc. were scheduled for re-development. The area occupied by the machine shops etc. was re-designed to accommodate three pre-fabricating sheds as large as the space would permit, with the open ends facing the open space at the head of the berths. Material was arranged to enter at the west end by transverse overhead gantry from the stock-yard and on completion of pre-fabrication to be taken out by over-head crane and thence by rail track to the pre-berth storage area, which was arranged on the area which had been originally Nos. 1 and 2 berths in the West Yard, sub-assemblies being handled by a travelling electric crane running down the centre of the area. The general lay-out is shown in Fig. 2.

Having decided upon the general principles of the lay-out, the development of the detailed arrangement proceeded as described below.

Pre-Fabricating Sheds

The area to be utilized by the new welding sheds covering the existing platers' shop, furnaces, etc. was about 55,300 sq. ft. and of this area some 35,800 sq. ft. being the space occupied by the frame furnaces, scrieve boards, beam machines, etc. was at a level 15 feet higher than the remainder, this change of level being abrupt—in the form of a vertical wall.

Having in mind that while re-construction work was being carried out, building was still to continue on the West Yard berths, and to interfere as little as possible with this production, it was decided to construct three welding sheds in the following order:—

No. 1 Shed On the area occupied by beam machines, punches, etc. work normally done by these machines to be undertaken by the East Yard machines.

No. 2 Shed On the area up to the wall occupied by the frame furnaces, blocks and scrieve boards, this transfer taking place during a programme of oil tankers, when little frame turning was necessary, which could be accomplished by the East Yard furnaces.

No. 3 Shed At a lower level on the area occupied by the Platers' shop, this being carried out after the last ship had been launched from the West Yard.

No. 1 shed was arranged to line up with existing Engine Works buildings and was made 275 feet long by 60 feet wide—No. 2 shed was 275 feet long by 70 feet wide, No 3 shed covering a smaller area being 217 feet long by 50 feet wide. Nos. 1 and 2 sheds were to be utilized as the "heavy" sheds and No. 3 as the "light" shed, the general lay-out of the Welding Sheds being as shown in Fig. 3.

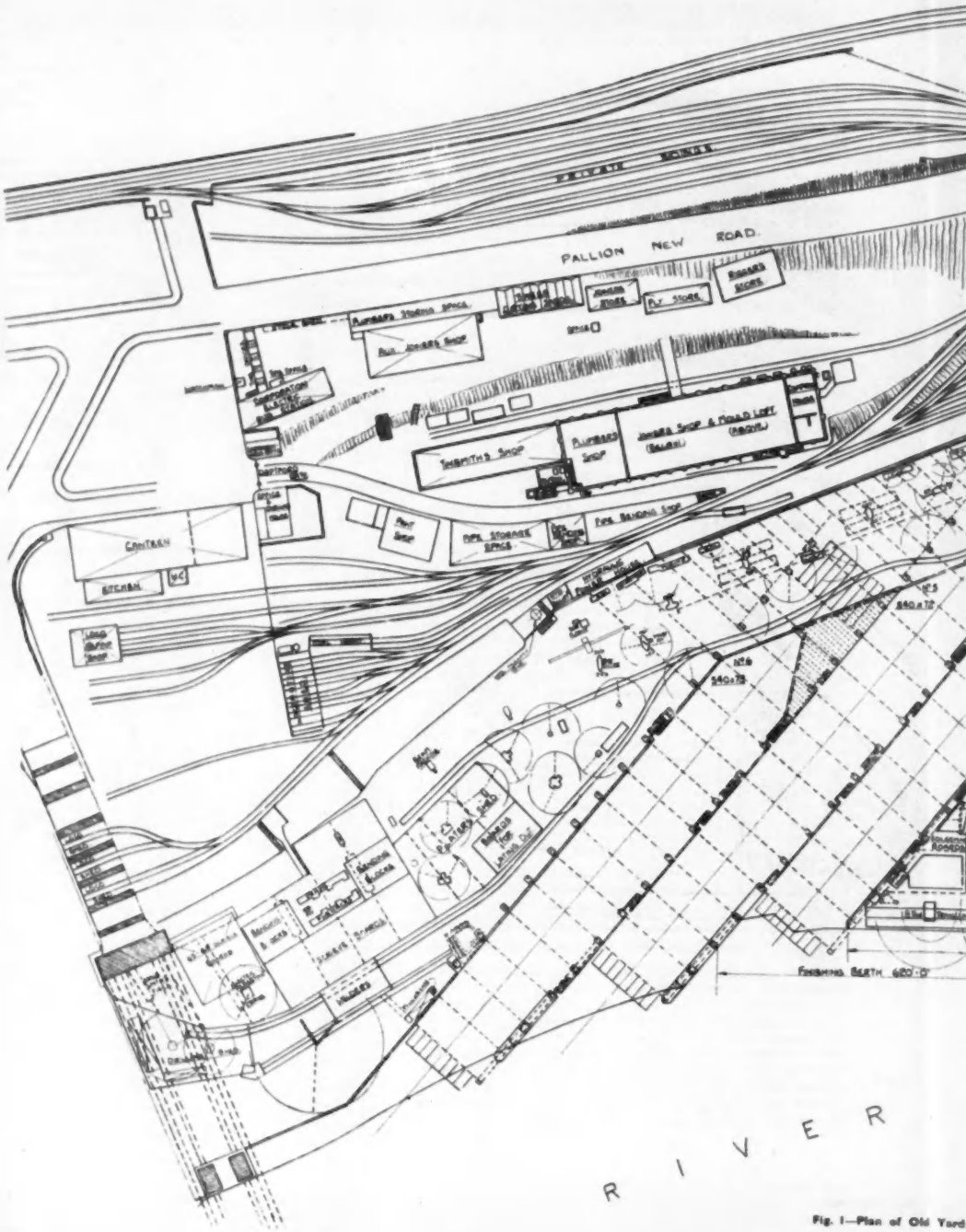
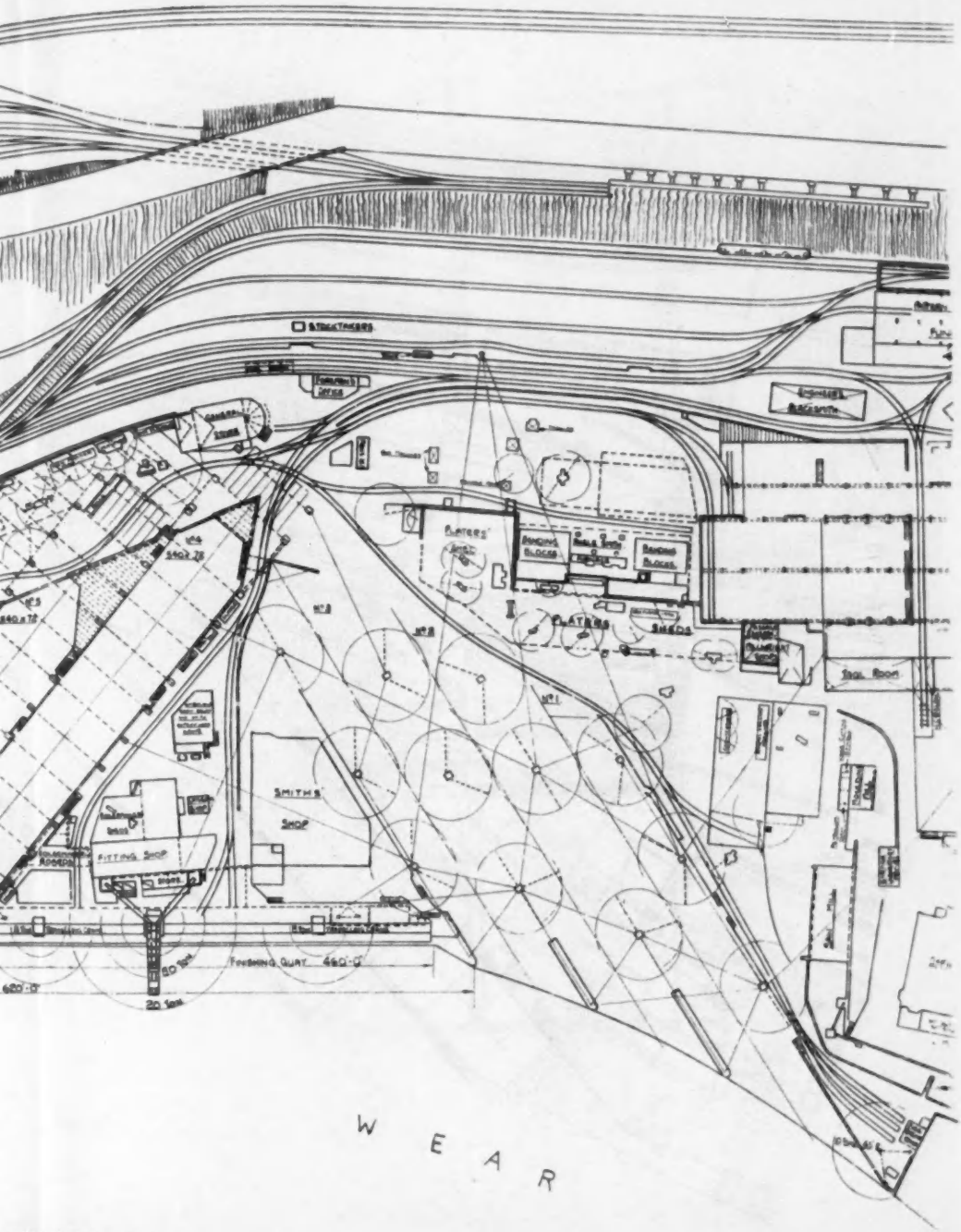


Fig. 1—Plan of Old Yard



of Old Yard Arrangement

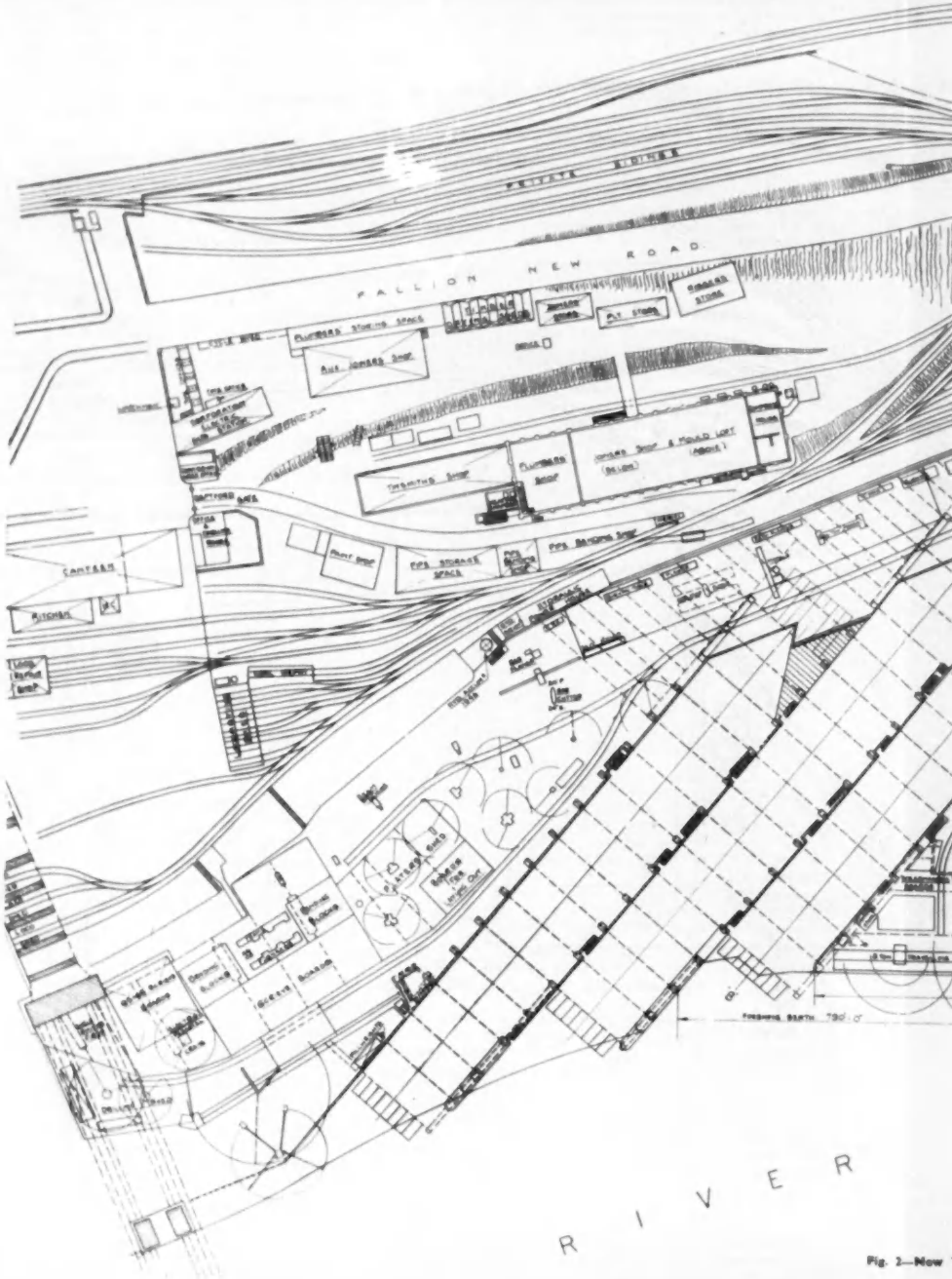


Fig. 2—Now

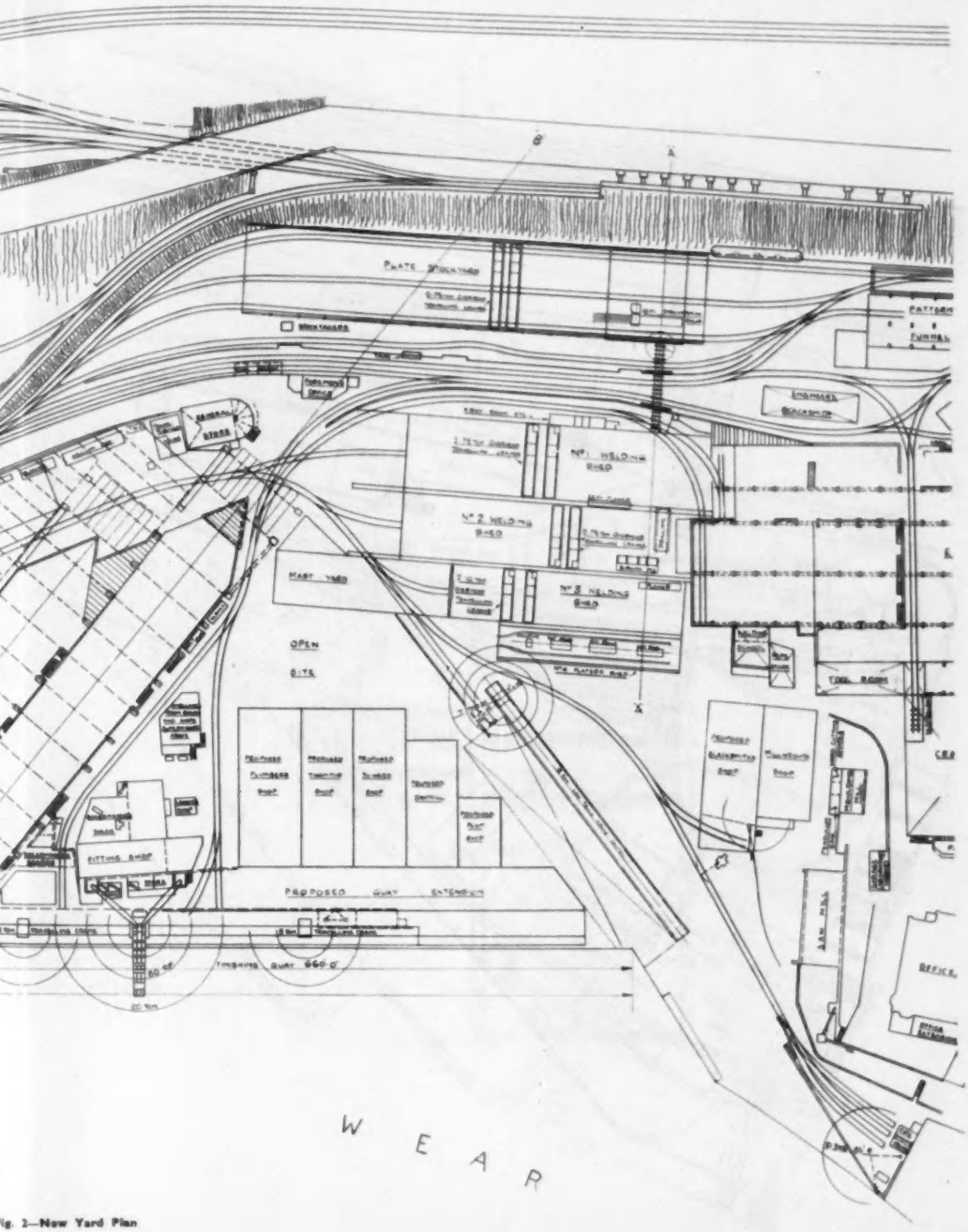


Fig. 2—New Yard Plan

In order to ascertain the height of Nos. 1 and 2 sheds some "yard stick" was necessary for the size of unit to be turned over. In general these units would consist of panels of deck plating, tank tops, bulkheads and the like with their attendant stiffening, being generally 35 to 40 feet in length and with the welded seams lengthwise. It was arranged for the sheds to have a height of 43 feet from floor to crane rails to enable such panels to be turned over with the welded seams vertical to avoid possible cracking of the first side weld.

No. 3 shed which was destined to be used for smaller units was not required to be so high and the height in this case was fixed at 35 feet from floor to crane rail.

The floors of all sheds are of concrete, with loose 6 in. channels arranged on the floor to support the units, this system being adopted as more flexible than a system of fixed supports.

It was recognized that the ideal routing for material was from stockyard to platers' shop and thence to welding shed, the latter being used entirely for welding purposes. Owing, however, to the platers' shop being in the East Yard, such a routing was uneconomical and it was decided to install in the sheds the minimum of machinery that could deal with material which came direct from the stockyard into the sheds via a transverse crane gantry.

The machines installed for this purpose are as follows:—

No. 1 Shed One 35 ft. high-speed planing machine.

No. 2 Shed One 40 ft. × 6 ft. profile burning table with double burning heads.
One 46 ft. × 12 ft. drilling table with two drilling heads.

No. 3 Shed One 30 ft. plate-edge planing machine.
One 35 ft. × 8 ft. plate-edge burning table.

These are placed at the west end of the sheds in order to leave as much floor space as possible for fabrication lay-out, this being approximately:—

No. 1 Shed 10,500 square feet.

No. 2 Shed 15,000 square feet.

No. 3 Shed 8,750 square feet.

Adjoining No. 3 Shed, which was to be used as the "light" shed, a small extension was erected measuring 167 ft. by 30 ft. to be used as a machine shop having the following equipment:—

16 ft. complete circle plate rolls.

12 ft. plate rolls.

6 ft. guillotine.

15 ft. 300 ton flanging press.

This equipment was to deal with such material as necessary for masts, derrick posts, tubular pillars, ventilator tubes, pressed minor bulkheads and all similar structures.

All welding sheds are served by overhead electric travelling cranes with cab, two in each shed as described under "Lifting Facilities." The crane girders for these cranes extend 50 ft. beyond the covered-in sheds to enable assembled units to be loaded on to bogies for transport to the storage area.

Pre-Berth Storage Area

As mentioned previously the area allocated for pre-berth storage was in the area occupied by Nos. 1 and 2 berths in the West Yard. This area is considerably affected by a tide rise, often in the region of 14 ft. and in order to obtain as much dry storage area as possible a rubble retaining wall was constructed across the river end of these two berths. A crane gantry was constructed running longitudinally down the centre of the area and, having in mind the size of unit most common—about 35 ft. by 25 ft. and weight not exceeding 15 tons—an electric travelling jib crane of 15 tons s.w.l. and 25 ft. jib radius was installed. The area available for storage is about 270 ft. long by 50 ft. wide on each side of the crane track, giving a total storage area of 27,000 sq. ft., and as the height from ground to crane rail is an average of 13 ft., it enables units to be tiered to a considerable height.

It was estimated that with the three-berth programme projected the material in progress would be about 80 per cent. of the weight of one vessel (approximately 3,300 tons) being 42 per cent. 30 per cent. and 8 per cent. for vessels on Nos. 1, 2 and 3 berths respectively at the laying of the keel of the vessel on No. 1 berth. Of this total about 60 per cent. would be pre-fabricated, thus space was required for some 2,000 tons of sub-assemblies and allowing for units being tiered it was considered that the area would be adequate.

Lifting Facilities

With pre-fabricated construction the factor governing lifting capacity is, of course, the size of sub-assembly and the arguments as to what may be the most economical weight and size of unit have been lengthy and conflicting. In this particular case, however, no such question arose. The East Yard berths, which are in docks some 20 ft. below yard level, are at varying levels transversely, with a distance between ships of only 13 ft., each berth being served by nine 3-ton electric travelling cranes running on longitudinal overhead tracks 90 ft. above the berth. With a system of lifting beams loads of 15 to 16 tons were the maximum. To adopt any other method of cranage on the berths was a financial and almost a practical impossibility and the whole system of lifting capacity in the development, together with the size of sub-assembly, was governed by the existing berth cranes and was not to exceed 15 tons.

Following upon this the overhead travelling cranes in Nos. 1 and 2 Welding Sheds were fixed at 7½ tons each, and those in No. 3 Shed, which were to be capable of lifting a completed mast for installing at the Fitting-Out Quay, were made of 10 tons capacity. The electric crane in the storage area is of 15 tons s.w.l. as already mentioned. Individual radial cranes with electric hoist blocks of 3 tons capacity were fitted at the planing machine in No. 1 Shed and at the mast rolls and guillotine in No. 4 Shed. The existing East Yard platers' shed is served by two overhead 5-ton travelling electric cranes, while individual 3-ton radial jibs are fitted at the countersink, plate rolls etc. General lifting throughout the transport system is carried out by steam loco-elephants with 3-ton radial jibs.

Stockyard and Material Movement

Material first arrives in a private siding adjoining British Railways, Sunderland to Durham line, and lies to the south of the yard boundary on the opposite side of a main public road. Movement of material is carried out by rail transport and is of necessity tedious, owing to the difference in level of the siding and the stockyard, which is 50 ft. Material must first come under the main road and then by zig-zag movement to the stockyard.

The stockyard covers an area 460 ft. long by 90 ft. wide and material is stored in racks.

With the new development an overhead crane gantry with two 5-ton electric travelling cranes has been erected over the area, doing the work which was previously done by steam cranes. To facilitate the direct movement of plates from the stockyard to the welding sheds, a transverse crane gantry was erected from the stockyard to No. 1 Welding Shed, fitted with a 3-ton underhung electric radial jib crane with remote control. At the stockyard end of this gantry a new set of 5-roll 10-ft. plate-straightening rolls has been installed, together with an electric winch and castor tables, with a view to one-man operation and so that all plates will be rolled before leaving the stockyard.

East Yard Platers' Shed

Prior to welding being adopted the machinery in this shed consisted of two one-man punching machines, two planing machines, plate mangles, bending rolls, two countersinking machines, two scarphing machines and two punching machines, shearing machines. In the new scheme one 1-man punch, the scarphing machines, punches, and shears, plate mangles and one countersink became obsolete and were scrapped. New machinery installed was two 35-ft. plate-edge burning tables, 4 radial drilling machines, and one 800-ton 40-ft. flanging press. Each planing machine was re-sited and fitted with castor tables to facilitate manual movement of plates.

Welding Facilities

Prior to the modifications all electric welding was carried out by single-operator direct-current welding sets. This was due, of course, to the electrical network in the yard being 230 volts d.c. Throughout the last fifteen years the increased use of electric welding had considerably overloaded the existing d.c. network and

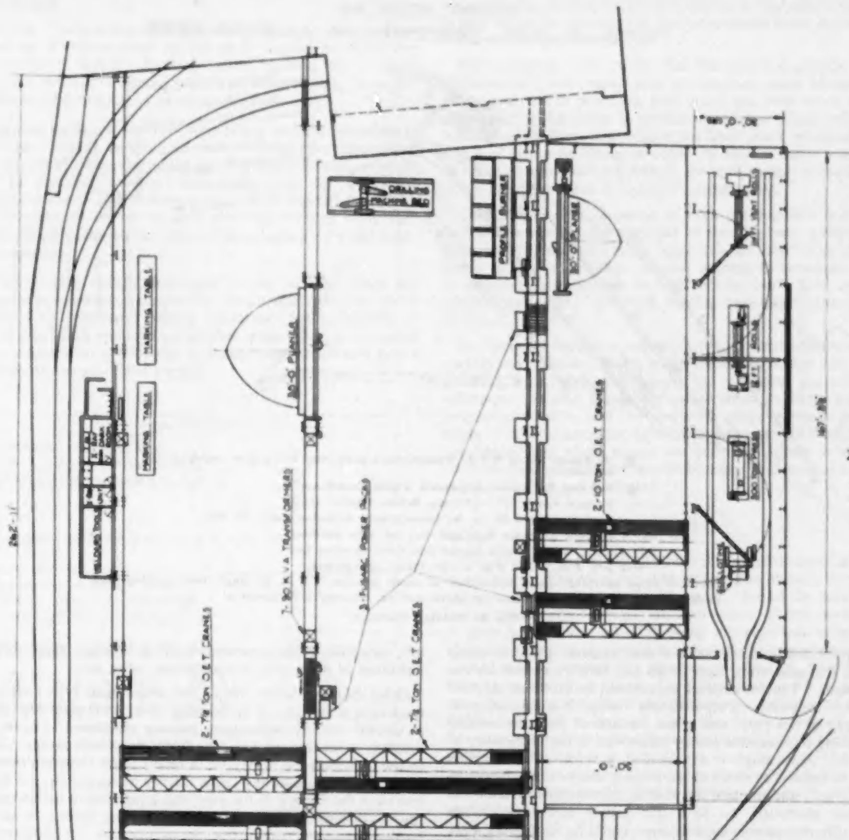


Fig. 3—Plan of Welding Sheds

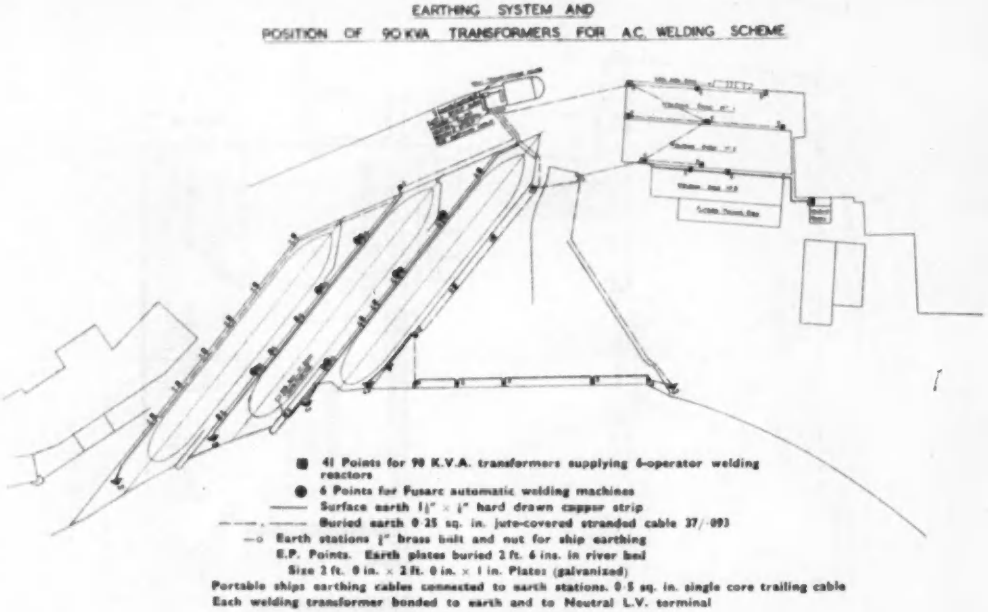

EARTHING SYSTEM AND
POSITION OF 90 KVA TRANSFORMERS FOR A.C. WELDING SCHEME
41 Points for 90 K.V.A. transformers supplying 6-operator welding reactors
6 Points for Fusarc automatic welding machines
Surface earth 1½" × ¼" hard drawn copper strip
Buried earth 0·25 sq. in. jute-covered stranded cable 37/·093
Earth stations ¾" brass bolt and nut for ship earthing
E.P. Points. Earth plates buried 2 ft. 6 ins. in river bed
Size 2 ft. 0 in. × 2 ft. 0 in. × 1 in. Plates (galvanized)
Portable ships earthing cables connected to earth stations. 0·5 sq. in. single core trailing cable
Each welding transformer bonded to earth and to Neutral L.V. terminal

Fig. 4—Welding Network

with the projected further increase it was necessary either to install additional d.c. generating plant or an a.c. network system for the welding plant. The d.c. network throughout the yard was supplied from rotary converters of considerable vintage in a substation at the east end of the yard, and it was considered that this method was involving considerable energy losses due to the inefficiency of conversion. Accordingly it was decided to install an a.c. welding network, to convert as much of the existing shipyard machinery as possible to a.c., and to place the existing d.c. overhead cranes and some other machinery on to a d.c. supply from mercury-arc rectifier. By this means the substation could be done away with, together with the B.E.A. staff necessary for the continuous manning of it, and so afford a considerable increase in conversion efficiency.

The a.c. welding network (Fig. 4) provided for 25 six-operator 90 k.v.a. transformers over the area of the building berths, 5 on the fitting-out quay, 10 in the welding sheds and one in the welding school. In addition six points were arranged on the berths for automatic welding machines in such positions that two machines can be in use on any one berth. Points were arranged in the welding sheds for automatic welding plant and at present four machines of two types are being used under cover.

Careful attention was paid to the earthing of the system, the main transformer being bonded to earth and earthing cable running in circuit through each welding transformer connected to galvanized earth plates buried in the river bed.

Plate-Edge Preparation

Welded construction has resulted in the production of individual plates to engineering limits either by plate-edge planing or burning and in the re-development scheme a combination of both systems was adopted. Plate-edge planing is used for all edge preparation for machine welding and burning is used for all edges which are to be fillet welded. It has been found in practice that for automatic welding a better fit-up is obtained with a planed edge and generally results in a better weld than that obtained with a gas-cut edge.

In No. 2 Welding Shed a 40 ft. long 6 ft. wide profile burner has proved most successful, burning from templates supplied from the loft, especially in the construction of oil tankers, where there is a repetition of parts such as transverses, webs, etc.

Other burning tables are of the single-head type running on trackways at the sides of the burning table, while plate edge planing is carried out by high-speed planing machines. The burning medium varies between acetylene and coal gas with oxygen. Owing to the increased use of oxygen in recent years an arrangement has been made with a local oxygen factory to supply oxygen by pipe line from the factory to the yard and a pipe line is led throughout the establishment, with valves at numerous points, so that the burner may simply connect his hose as necessary. This has resulted in a considerable saving in time previously taken in the transport of oxygen cylinders.

Inspection of Welding

The quality of welding depends largely upon the extent of inspection and at the outset an effort was made to have one welding supervisor for every twelve welders. Because of existing labour conditions great difficulty has been experienced in obtaining sufficient numbers of qualified supervisors and this target has not been achieved.

Before welding commences the supervisor examines the joint and, having satisfied himself on the preparation, he indicates to the welder the procedure to be adopted, which is noted both by welder and supervisor (for payment purposes).

It is the duty of the supervisor to examine each weld on his circuit as work proceeds, but owing to the number of welders he has to cover it is impossible for him to examine every part of every weld. In order to satisfy the builders, owners and classification society on the quality of the welding, X-ray photography has been adopted on a fairly large scale; about one hundred and fifty photographs have been taken per vessel. In cases of faults the X-ray photograph is shown to the welder, the fault is pointed out to him and he then repairs the weld.

Apart from the fact that the X-ray photograph gives a measure of satisfaction and proof of sound procedure, it also serves to some extent as an insurance, in so far as it tends to improve the conscientiousness of the welder, to whom it gives some satisfaction to see the results of his efforts.

Welding Details

All details of edge preparation and type of joint are indicated on the working drawings issued to the yard; typical examples are shown in Figs. 5 and 6. As to the actual welding procedure of the joints, a measure of elasticity has been adopted in so far as no fixed scheme of procedure is issued to the welder.

For general guidance, however, a scheme of welding procedure is issued (Figs. 7 and 8), covering the most common joints and giving details of size of electrode, amperage and length of run for ideal fit-up. In practice, however, and particularly for positional welding on the berth, where fit-up varies, a hard and fast procedure cannot be adhered to and in such cases the welding supervisor gives instruction to the welder regarding procedure for the particular joint in question.

For all plating welded downhand in the welding sheds the square edge preparation is adopted for thicknesses up to ½ in. which are welded by automatic welding machines; for thicknesses in excess of this, which are to be turned over in the sheds, a bull-nosed chamfer preparation is adopted, to ensure penetration and give a finish without excess reinforcement.

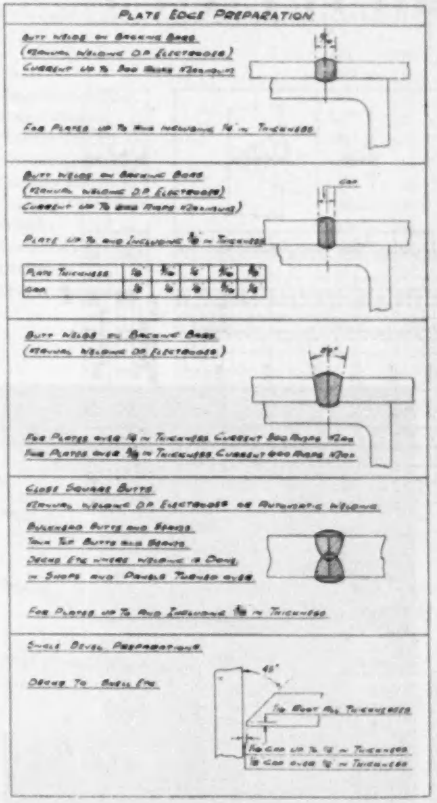


PLATE EDGE PREPARATION
BUTT WELDS ON BACKING BARS
(MANUAL WELDING OR ELECTRODES)
CURRENT AND % BAR RUNS REQUIRED
FOR PLATES UP TO AND INCLUDING ¼ in. THICKNESS
BUTT WELDS ON BACKING BARS
(MANUAL WELDING OR ELECTRODES)
CURRENT AND % BAR RUNS REQUIRED)
PLATE UP TO AND INCLUDING ⅜ in. THICKNESS
PLATE THICKNESS
GAP
BUTT WELDS ON BACKING BARS
(MANUAL WELDING OR ELECTRODES)
60°
FOR PLATES OVER ¼ in. THICKNESS CURRENT AND RUNS REQUIRED
FOR PLATES OVER ⅜ in. THICKNESS CURRENT AND RUNS REQUIRED
CLOSE SQUARE BUTTS
(MANUAL WELDING OR ELECTRODES OR AUTOMATIC WELDING
BACKING BUTTS AND BRACES
TACK THE BUTTS AND BRACES
DRIVE ETC. WHERE WELDING IS DONE
IN SHOPS AND DOUBLE TURNED OVER
FOR PLATES UP TO AND INCLUDING ⅜ in. THICKNESS
SINGLE BEVEL PREPARATIONS
DRIVE TO BUTT ETC.
45°
GAP

Fig. 5

For joints to be welded on the berth with manual welding a 60° single vee preparation is used for plates up to ½ in. in thickness, and a 60° 2/3rds, 1/3rd preparation for thicknesses in excess of ½ in. This latter preparation is used mainly for the joining of bottom shell panels, where the overhead run is completed first manually, followed by the downhand run by automatic welding. This method shows a saving of weld metal over the open vee preparation and omits the cutting out for the overhead run, which was found in practice to be uncertain, in that penetration from the underside could not be guaranteed.

For horizontal welds on the shell the joint first adopted was the horizontal 45° vee preparation, this method being economical in weld metal, but in practice it was found that there was a tendency on the part of the welder to weld in a semi-downhand position and build up on the horizontal edge of the lower plate, which resulted in a lack of fusion on the upper edge. In view of this it was decided to adopt an open vee preparation for shell seams; although more costly it is considered to produce a better joint.

The joining edges of panels of deck plating, tank top plating, deck-house tops etc. are arranged on backing bars, a requisite gap being left between the joining edges and the joint being completed either by deep penetration manual welding or automatic welding to ensure penetration on to the backing bar. This method is adopted to cut out overhead welding and allow some elasticity of fit-up.

Scalloping is used on a large scale for bulkhead stiffeners, beams, deck-house stiffeners, floors, transverses, web frames etc. not only resulting in a saving of weight but reducing distortion to a minimum. It also avoids the crater effect usual at the end of intermittent welds, and the corrosion effect between the faying edges of stiffener and plate between the intermittent welds, and it is considered that where spaces are carrying liquids or subject to condensation, all stiffeners should be either scalloped or a continuous double fillet weld adopted.

Labour

The introduction of welding into ship construction has resulted in a general change in the man-power distribution in the yard, welders and burners replacing riveters. One of the main features in the re-organization was the breakdown of the squad system of plate preparation, handling being accomplished by individuals which has resulted in a considerable reduction in platers' helpers. Comparison of present-day man-power with that prior to World War II is shown in Table I. Unfortunately the economy of shipyard electric welding is suffering from conditions of payment, which have not progressed with the development of welding. Payment is not always directly associated with output for different types of weld, and it is hoped that through time some suitable piecework price relative to output can be sensibly applied, and that the welding department will have a balanced position in the steel-working trades.

The intake of apprentice labour into the shipbuilding industry gives cause for alarm, the modern youth seeming to shun shipyards and preferring industries where mechanization and scientific methods of production make for easier working conditions and less brain fatigue. In this respect electric welding with the pre-fabricated method of construction does offer easier conditions of working and the facilities provided require labour with less skill. It accordingly offers working conditions more in keeping with the requirements of this age and should tend to ease the problem of labour recruitment.

Unfortunately too, the British shipowner is by nature cautious and very reluctant to give up methods of construction which have proved so serviceable for many years, and there exists still an inherent mistrust of the shipbuilder when he suggests something new. In conditions such as these a shipbuilder cannot plan his manpower for wholly welded construction and this necessitates the retention of a certain number of riveting squads. The design must often include a limited amount of riveting to keep this trade available to the establishment. As we approach steadily the time when the welded ship will be the accepted article the transference of riveters to the trade of welding can be completed, and further economy in construction achieved.

Conclusion

The planned reorganization of the yard is at present suffering setbacks through the national economy and owing to the serious curtailment of steel supplies over the last twelve months it has not been possible to measure with consistency the advantages of the new lay-out.

PLATE EDGE PREPARATION

Single Vee Preparation (Manual Welding)

Applicable to Butts and Seams of Keel Tank Top Decks Bulkheads Shell (and Bottom Shell where welded in Position) Vee Weld to be Done in Downhand or Vertical Position

½ Root ⅛ Gap up to and including ⅝
⅝ Root ⅛ Gap over ⅝

Horizontal Vee Preparation (Manual Welding)

Applicable to Shell Seams Built Seams Etc. where Horizontal Welding is necessary

½ Root ⅛ Gap up to and including ⅝
⅝ Root ⅛ Gap over ⅝

Double Vee Preparation (Manual Welding)

Butting Shell Butts with welded in Double End in all Plates over ⅝ in Thickness when Tab is Turned over and Welding Done in Downhand Position

Double Vee Preparation (Automatic Welding)

Butting Shell Butts and Seams Etc.

Plate Thickness	a	b	c
68 – 79	3/32	11/32	1/16
80 – 110	1/4	1/4	-
111 – 124	5/16	1/4	-
125 – 135	3/8	1/4	-
136 – 149	7/16	1/4	-
150	1/2	1/4	-

Fig. 6

120A PREPARATION

PREPARATION FOR BACKING RUN

Plate Thickness	Run No	Weld Position	Electrodes Type	Dia.	Amps	Run Length (ins. or No.)	Key to Runs
22	1	D.H.	M.P.	4.0	185	12	
30	1	D.H.	M.P.	4.0	185	8	
	2	"	"	4.0	210	8	
35	1	D.H.	M.P.	4.0	210	8	
	2	"	"	4.0	210	8	
40	1	D.H.	M.P.	4.0	210	11	
	2	"	"	4.0	210	11	
45	1	D.H.	M.P.	4.0	210	11	
	2	"	"	4.0	480	11	
50	1	D.H.	M.P.	4.0	210	15	
	2	"	"	4.0	480	15	
55	1	D.H.	M.P.	4.0	480	9	
	2	"	"	4.0	480	9	
60	1	D.H.	M.P.	4.0	210	13	
	2	"	"	4.0	480	13	
65	1	D.H.	M.P.	4.0	210	13	
	2	"	"	4.0	480	13	
70	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
75	1	D.H.	M.P.	4.0	210	15	
	2	"	"	4.0	480	15	
	3	"	"	4.0	600	15	
	4	"	"	4.0	600	15	
80	1	D.H.	M.P.	4.0	210	11	
	2	"	"	4.0	480	11	
	3	"	"	4.0	600	11	
	4	"	"	4.0	600	11	
85	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
	3	"	"	4.0	600	10	
	4	"	"	4.0	600	10	
90	1	D.H.	M.P.	4.0	210	13	
	2	"	"	4.0	480	13	
	3	"	"	4.0	600	13	
	4	"	"	4.0	600	13	
95	1	D.H.	M.P.	4.0	210	12	
	2	"	"	4.0	480	12	
	3	"	"	4.0	600	12	
	4	"	"	4.0	600	12	
100	1	D.H.	M.P.	4.0	210	11	
	2	"	"	4.0	480	11	
	3	"	"	4.0	600	11	
	4	"	"	4.0	600	11	

BACKING RUNS

Plate Thickness and Weld	Run No	Weld Position	Electrodes Type	Dia.	Amps	Run Length (ins. or No.)	Key to Runs
Overhead			Overhead				
22 and under	1	D.H.	M.P.	4.0	180	11	
over 22	1	D.H.	"	4.0	180	11	
	2	D.H.	"	4.0	180	11	
			Downhand				
75 and under 100	1	D.H.	M.P.	4.0	210	11	
		D.H.	"	4.0	480	11	

Fig. 7

WELDING PROCEDURE SPECIFICATION 4
DOWNHAND FILLETS

Plate Thickness	Run No	Weld Position	Electrodes Type	Dia.	Amps	Run Length (ins. or No.)	Key to Runs
18	1	D.H.	M.P.	4.0	210	10	
20	1	"	"	4.0	210	10	
25	1	"	"	4.0	210	10	
30	1	"	"	4.0	210	10	
35	1	"	"	4.0	210	10	
40	1	"	"	4.0	210	10	
45	1	"	"	4.0	210	10	
50	1	"	"	4.0	210	10	
40	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
45	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
50	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
55	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
60	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
	3	"	"	4.0	600	10	
	4	"	"	4.0	600	10	
65	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
	3	"	"	4.0	600	10	
	4	"	"	4.0	600	10	
70	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
	3	"	"	4.0	600	10	
	4	"	"	4.0	600	10	
75	1	D.H.	M.P.	4.0	210	10	
	2	"	"	4.0	480	10	
	3	"	"	4.0	600	10	
	4	"	"	4.0	600	10	

Fig. 8

The first vessel constructed under the new conditions was a 16,750 tons deadweight oil tanker having a steel weight of 4,100 tons of plates and sections. Work on this vessel was commenced 17 weeks prior to the keel's being laid and at the date of keel laying 51 per cent. of the steel had been fabricated. From keel laid to launch the berth time was 22½ weeks, which included two holiday weekends; the erection progress chart is shown in Fig. 9.

The output of the welding sheds has also varied considerably, owing to the restricted flow of steel, and the output in tons fluctuates according to the scantlings of structures passing through. Taken over a period of 12 months this tonnage varies from 110 tons to 170 tons weekly, and as a general average the output per week is in the region of 145 tons.

The first year of working with the new lay-out has been generally satisfactory and it is considered that when we approach the Utopia of unlimited steel considerable economies will result.

Acknowledgment

The Author would like to express acknowledgments to the Directors of Messrs. William Doxford & Sons Limited for their kind permission to publish this paper and for the use of the photographs and data included herein.

TABLE 1—*Comparison of Man-Power in Steel Trades*

	1936	1951
Platers	125	118
Platers Apprentices	54	16
Platers Helpers	340	201
Riveters, Holders-up, Heaters	301	101
Riveters Apprentices	21	11
Caulkers and Burners	37	71
Caulkers Apprentices	30	20
Welders	18	154
Welders Apprentices	2	48
Drillers	36	35
Drillers Apprentices	29	2
Totals	993	777

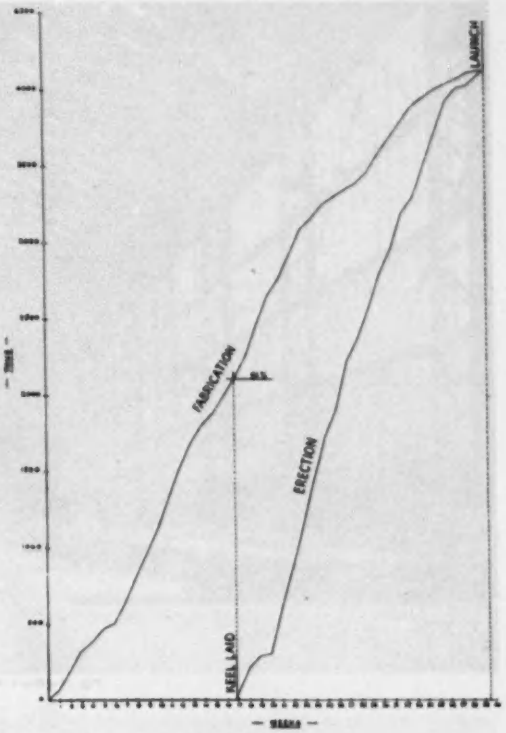


Fig. 9—Steel Fabrication and Erection

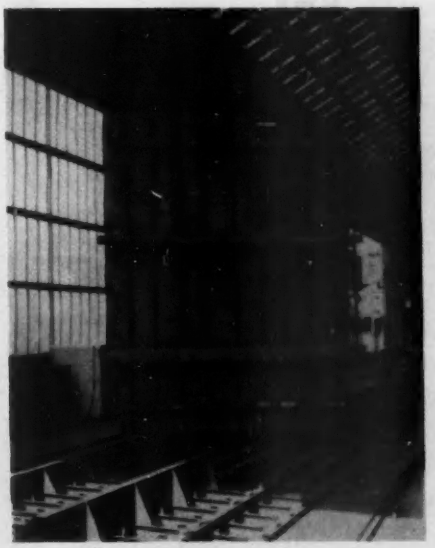


Fig 11.—Lifting Bulkhead in No. 1 Welding Shed

Fig. 12—Lifting Double-Bottom Units in No. 2 Welding Shed

Fig. 12—No. 1 Welding Shed

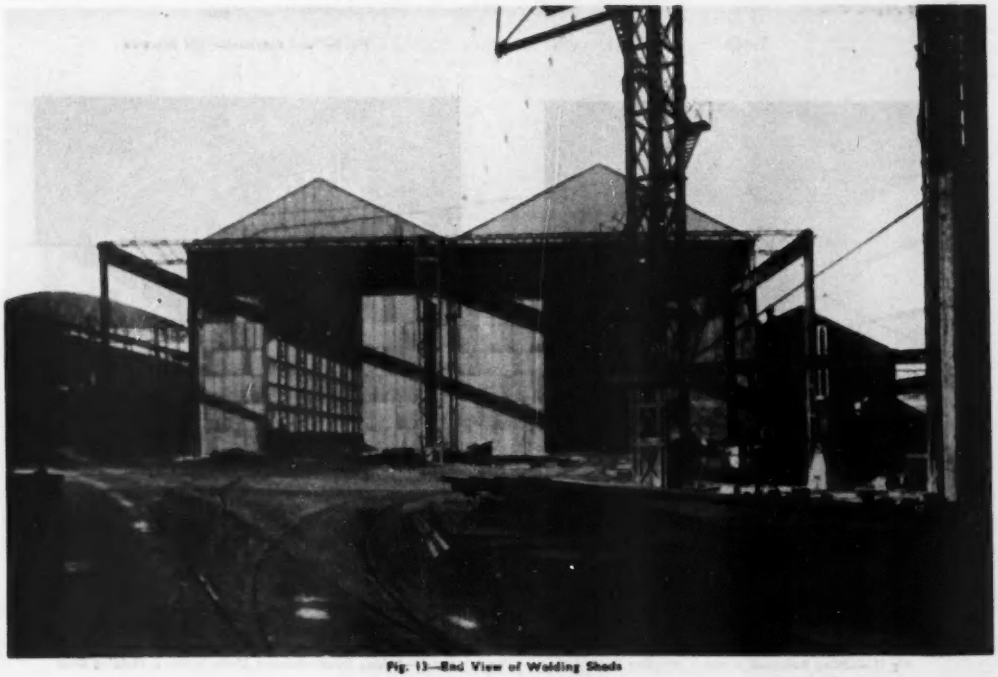


Fig. 13—End View of Welding Sheds

Fig 14. No. 3 Welding Shed

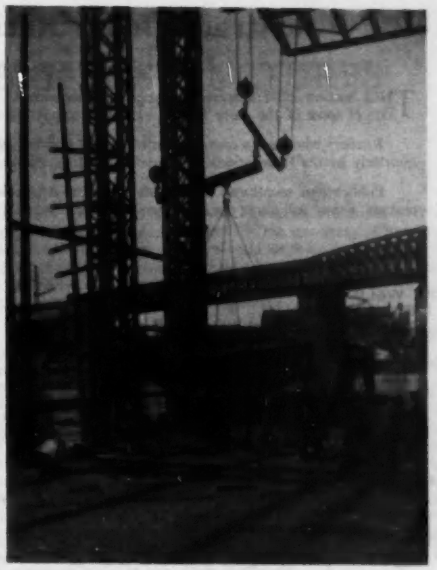


Fig. 15. Positioning Double-Bottom Units on berth

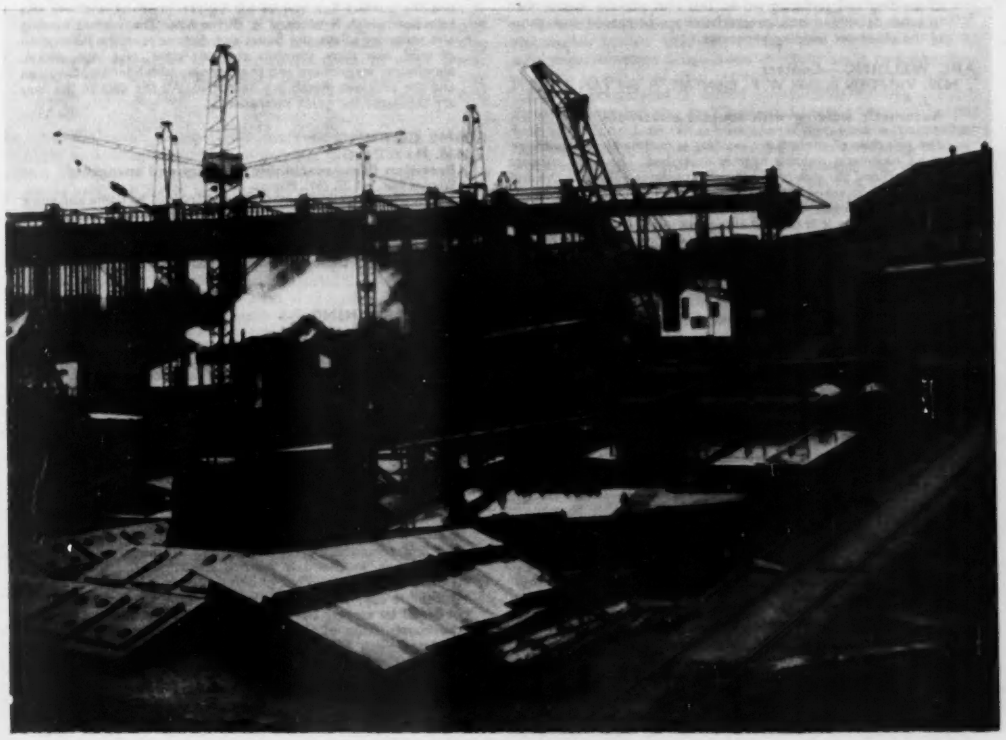


Fig. 16. Pre Berth Storage Area

Abstracts from Recent Welding Literature

(Compiled by J. L. SANDERS)

THIS section of *Transactions* makes no pretension to completeness but is intended only to provide readers with particulars of some of the more interesting papers appearing in recent welding periodicals.

Readers who need a complete survey should consult the *Bibliographical Bulletin for Welding and Allied Processes* published quarterly by the International Institute of Welding. Particulars may be had from the Secretary of the Institute.

Publications mentioned in the lists below are available on loan to members of the Institute and borrowers will facilitate matters if they will quote the appropriate reference number printed beside each entry.

ARC WELDING

1628. HAUTTMANN, H.

Get better welds with iron powder back-up

Iron Age, vol. 169, 1952, May 8, pp. 116-118

Several advantages are claimed for back-up bars made of iron powder pressed into a light sheet metal trough. The bars are used as-pressed or slightly sintered and may be bent to a large radius. Tests made on SAE 1015 and 1025 steels indicate that hardening due to rapid heat dissipation is counteracted and the necessity for chiselling out and rewelding the root of the seam is eliminated.

1629. LEBRUN, W.

Une nouvelle méthode de soudage electrique a l'arc: le procédé Plurial

Soudure et Techniques Connexes, vol. 6, 1952, Mar.-April, pp. 55-63

In the "Plurial" process a number of electrodes of equal diameter are held together and supplied with a current sufficient to fuse them. The electrodes do not fuse simultaneously, but the arc moves rapidly from one to another in a sequence. The number of electrodes is variable and they may be of differing compositions, thus permitting a wide variety of welding and surfacing work. This new process is described in some detail and its characteristics are compared with those of the other arc welding processes.

ARC WELDING.—Contact

1630. VAN DEN BLINK, W. P., BIENFAIT, H. and VAN BERGEN, J. A.

Automatic welding with contact electrodes

Philips Tech. Review, vol. 13, 1952, Mar., pp. 247-253

The principle of contact arc welding is outlined and the design of an automatic welding head is described. This head consists of an inclined bar mounted between insulated rollers to the end of which is attached the electrode at a given angle. The weight of the bar presses the electrode on to the work and as the electrode melts it is carried along the joint. A number of such heads are mounted on a bar above a workpiece and each electrode takes over the arc from the previous one when the latter is consumed. Diagrams and photographs of the equipment illustrate the text.

ARC WELDING.—In Inert Atmospheres

1631. BREYMEIER, R. T.

Metal transfer in sigma welding

Welding J., vol. 31, 1952, May, pp. 393-399

Metal transfer across the arc was investigated by high speed photography and the effect of this transfer, specific conditions of current, shielding gas and rod material on the weld bead is discussed. The materials considered were mild steel, stainless steel and aluminium and beads were deposited on to flat plate with 1/16 in. diameter wire and currents ranging from 100 to 500 amperes.

ARC WELDING.—Submerged Arc

1632. CLAPP, E. A. and SCHREINER, N. G.

Characteristics of submerged arc welding with three-phase power

Welding J., vol. 31, 1952, June, pp. 479-485

Welding speeds between two and three times faster than those obtainable with single phase equipment are claimed for this system employing two electrode wires arranged in close tandem and connected across two phases of the supply with the third phase connected to the workpiece. Phase angle between the two electrode currents, phase sequence and power distribution between the electrodes have a pronounced effect upon the quality and appearance of the weld and the plant draws a balanced load from the three phase supply at a high power factor.

1633. CONSTANTINE, L. R.

Glass tape backs up welds for jet ejector

Welding Eng., vol. 37, 1952, June, pp. 36-37

A method of backing up welds made by the submerged arc process consists of a glass tape having a basic composition similar to that of the submerged arc flux.

1634. DRAHOS, F. R.

Shielded, submerged arc welds withstand rugged service

Steel, vol. 130, 1952, April 14, pp. 94-96

The application of submerged arc welding to heavy equipment is described. Examples quoted include the welding of stainless to carbon steel forgings and castings in large pump assemblies, cast weld construction and the construction and repair of tools used in the oil industry. Notes on preheat and stress relief treatment are given.

BRAZING

1635. CLAUSER, H. R.

Brazing and soldering materials

Materials and Methods, vol. 35, 1952, Mar., pp. 105-120

It is most important that the correct brazing alloy or solder and the correct flux is used for a given material, and it is this selection which is covered in this article. The various brazing and soldering alloys and fluxes and their uses in the fabrication of mild, low alloy, stainless and cast steel, cast iron, nickel, aluminium, magnesium and their alloys, molybdenum, tungsten and the precious metals are described. All the data in the text are tabulated for quick reference.

FLAME CUTTING

1636. MAXON, G.

Precision flame-machining of gears and sprockets

Welding Eng., vol. 37, 1952, May, pp. 34-36

The author describes a machine constructed to flame cut gears from 2½ in. diameter to 96 in. diameter, in which the blank rotates at a constant velocity about its centre and the cutting torch oscillates along a diameter by means of a cam. The combination of these two motions generates the desired tooth profile.

FLAME HARDENING

1637. ANON.

Temperature controlled flame hardening

Metallurgia, vol. 45, 1952, Mar., pp. 135-137

This article describes an attachment for accurately controlling the temperature of flame hardening operations and of rendering the machines automatic. The principle on which this attachment works is that of the disappearing filament pyrometer.

HEAT TREATMENT

1638. ANDERSON, C. A., COREY, D. H. and DENMAN, H. J.

Pipe weld normalizing and stress relieving

Welding J., vol. 31, 1952, April, pp. 324-329

In the older methods of 60 cycle induction heating, copper tube, insulated with asbestos sleeving, was employed for the inductor coil and temperature regulation was by means of a tapped transformer. In the new method described the transformer is discarded and a number of unit coils are connected in series across the supply mains. The coarse temperature regulation is obtained by varying the number of coils. The material used in the construction of these coils is rectangular copper tubing insulated with fibreglass sleeving impregnated with silicone varnish. Calculations for the design of the coils are given. Reference is made to a previous article in the same journal and it is noted that the metallurgical effects described therein are not changed by the new system.

(*Continued on page* 124)

LIGHT WEIGHT WELDED CONSTRUCTION IN MECHANICAL ENGINEERING STRUCTURES

By F. KOENIGSBERGER, M.I.Mech.E.*

1 Theoretical Basis

It is well known that considerable saving in weight of material is possible by the use of rolled steel instead of cast iron in the construction of mechanical engineering structures. This is due mainly to the higher permissible stresses and the greater value of Young's modulus for steel as compared with cast iron, and partly to the fact that in fabricated construction no consideration has to be given to possible core displacements, the manufacturing difficulties caused by abrupt changes in wall thicknesses, relatively large machining allowances, etc.

From the designer's point of view, stiffness and strength of a structure have to be considered. The stiffness K against deformation under load is usually taken as the ratio between the load P and the deformation δ, $K = \frac{P}{\delta}$, the unit for K being chosen, for instance, as 1,000 lbs. per 0·001 in. deformation. Then unit $K = 1{,}000{,}000 \frac{\text{lb.}}{\text{in.}}$ The strength of the design can be judged from the ratio S between load P and design stress f, i.e. $S = \frac{P}{f}$. Full use is made in a structure of the material properties if K corresponds to the requirements of the structure under consideration and S is in accordance with the maximum stress considered permissible for the loading conditions and the material used. It is generally appreciated that this is possible only if in the design every consideration is given to the mechanical properties of the materials used. In other words, shapes, sizes, and wall thicknesses used in fabricated steel construction have to be entirely different from those used for iron castings.

For the simple example of a freely supported beam,† which might be a schematical form of bedplate (Fig. 1), it will be seen that the ratio of the square of the free length l to the depth d has to be very different for a cast-iron structure as compared with a mild steel structure, if both strength and stiffness are to be used to full advantage. There is only one value of this ratio which results in minimum weight of the structure. This optimum value may not always be obtainable on account of other design requirements. In most cases of machinery structures it will, in fact, be necessary to work towards the right of the graph, thus obtaining the required stiffness at stresses well below those which are considered permissible for the material in question. It is important, however, to remember that the ratio $\frac{l^2}{d}$ has to be smaller for steel, in other words, free lengths have to be reduced and depths of sections have to be increased as compared with the optimum conditions for cast iron.

The weight of a welded structure is not only of economic significance. In the case of high speed machinery the problems of rigidity against vibration, particularly the prevention of resonance, are of great importance. Resonance conditions can be avoided if the natural frequency of the structure lies as far away as possible from the frequency of working vibrations (speed of rotating masses, etc.) in the machine. If the machine under consideration has to run at different speeds, it is safest to keep the natural frequency of its structure high, i.e. well above the maximum speed, in order to avoid resonance vibrations over the working range. In a manner similar to the specifying of maximum permissible stresses or maximum safe working loads, which are related to the ultimate loading or stressing capacity of a component, it is possible to specify a minimum permissible natural frequency as a criterion for safety against resonance.

As the natural frequency of a structure grows with increasing stiffness and decreasing mass ($f_0^2 = C\frac{K}{m}$), a structure with a high natural frequency will be obtained by combining high values of stiffness with low weight ($W = m \cdot g$). The graph (Fig. 2) shows for the case of the freely supported beam the relation between weight W and natural frequency f_0 for different values of K. The chain-dotted line divides the graph into two fields marked "heavy construction" and "light construction" (Krug, 1940). In the high range of weights, marked "heavy construction," small increases in the natural frequency can only be obtained by considerable reductions in weight. However, in the low range, marked "light construction," considerable increases in the natural frequency can be obtained by slight reductions in weight.

So far the relationship between stiffness, strength, frequency and weight has been discussed only from the point of view of the dimensions, i.e. the relationship between length, depth and width of the solid beam which was taken as an example. The plain, solid, rectangular section used in castings and weldments has its advantages in welded design if cost of labour has to be a minimum, as it can be produced from plate material. In order to make full use of the possibilities of welded construction, however, not only the dimensions but also the shapes and forms of the components have to be considered. In contrast to casting, welded construction has few practical limitations with regard to combining different wall thicknesses and creating closed box sections. This enables the designer to *distribute* the material in such a way as to make the greatest use of its working properties and to avoid wasting it where it is not useful.

Fig. 3 compares strength and stiffness in bending (suffix b) and torsion (suffix t) for beams of four typical cross sections having equal weights (volume V) lengths l and depths d. The sections are: (1) the solid rectangular section as discussed earlier, (2) the H-section which comes second in order of cost of manufacture, (3) the tubular section, and (4) the rectangular closed box section. It will be seen that within the practical range of width/depth ratio k the closed box section is the most favourable, its slight inferiority to the tubular section in torsion being more than compensated for by its qualities in bending.

The weight of material required to obtain a specified value of stiffness or strength at a specified length depends upon the cross-sectional area of the section. It can be proved (see Appendix) that, as the depth d of a closed box section increases, for specified values of K_b (stiffness in bending) or K_t (stiffness in torsion), the cross-sectional area and with it the weight of material in the beam, decreases in proportion to d^2, and for specified values of S_b or S_t in proportion to d (equations 5 to 8 in the Appendix). Furthermore, *structures of specified strength and stiffness conditions and of very low weight can be obtained by using box sections of large overall dimensions with very thin walls* (see Equations 9 to 13 in the Appendix).

These equations are given in graphical form in Figs. 4 to 8 for the convenience of the designer who has to determine the minimum possible wall thicknesses t for a particular design and for specified stiffness and strength values. The values t found from the graphs for unit K or S should be multiplied as follows:

* Manchester College of Technology.

† In the following calculations of bending strength and stiffness only deflections and stresses due to bending are considered. It should be remembered, however, that the influence of shear depends on the ratio $\frac{d}{l}$ and cannot always be neglected.

(a) In the case of K_b :

by the specified value of K_b and by $\left(\frac{l}{36}\right)^3$

(b) In the case of S_b :

by the specified value of S_b and by $\left(\frac{l}{36}\right)$

(c) In the case of K_t :

by the specified value of K_t and by $\left(\frac{l}{36}\right)$

(d) In the case of S_t :

by the specified value of S_t .

In order to make a rough allowance for deflection due to shear, it is recommended to multiply the values found for *t*:

$$\text{by 2 if } 4 > \frac{l}{d} > 2$$

$$\text{by 4 if } 2 > \frac{l}{d} > 1$$

Against the favourable properties of thin walled large box sections, such as strength, stiffness and low weight with resulting high natural frequency and safety against resonance, a limitation of their loading capacity arises from the danger of warping and buckling of the thin walls under the shearing stresses (Morse, 1941; Timoshenko, 1944). The calculation of actual buckling stresses and critical loads is usually on the very safe side, as the plate walls are generally assumed freely supported, whilst they are at least in a partly clamped condition owing to the stiffness of the corners and corner joints. It should be recognised, however, that the buckling load decreases with the square of the width of the wall and increases with the cube of the wall thickness. This means that the danger of walls buckling is greatest in sections of large overall size and small wall thickness. Furthermore, the lower the stiffness against buckling the lower is the natural frequency of the sheet panel which forms the wall of a box section, with consequent increasing danger of resonance vibrations in the panel. The requirements of strength, stiffness and vibration rigidity of the sheet panels are, therefore, directly opposed to those which concern the box section as a whole.

Two methods have been introduced to overcome this difficulty (Fig. 9). The first one, already well established in aircraft design, is the so-called "shell construction," in which the panels forming the thin "shell" of the large box section are stiffened either by webs or by suitable bends or corrugations in the sheet material itself. In the other method, the "cellular" construction, first introduced by Krug, in the design of fabricated grinding machine structures (Krug, 1933), the box section is subdivided into small "cells." These cells, which present members of small free lengths and great depth, result in walls of high resistance to bending and buckling (see Fig. 1).

One further point has to be considered. The behaviour of a machinery structure under conditions of vibration is influenced not only by its stiffness and its natural frequency, but also by its damping capacity. This damping capacity does not only depend upon the properties of the material employed, but also upon certain design features. In the case of welded machine structures the damping action is considerably influenced by the effect of their component parts upon each other. The effect of "rubbing surfaces" has been studied by Kettner (Kienzle and Kettner, 1939) and Heiss (1949-50) (Fig. 10, top). The three cantilevers shown have identical lengths *l* and cross-sections *b* . *t*, but cantilever I was made from one piece, whilst cantilevers II and III were welded together from two pieces of half the total thickness each. Cantilever II had a gap between the two components. The component parts of cantilever III were preloaded before welding, in such a way that not only was there no gap but some pressure existed between the two contact faces. The result was an increase in the damping capacity of cantilever III to about 64 times the value found for cantilevers I and II. This can be attributed to the rubbing action between the two faces of the components. Such rubbing faces are almost automatically created in spot-welded structures designed on the cellular principle (Fig. 10a). They can be provided in other structures by suitable design (Fig. 10b), with the resulting excellent vibration damping characteristics of structures designed in accordance with this method.

2. Practical Approach

It must appear that there are few disadvantages to be set against the very great advantages which can be obtained with the light-weight construction methods which have been described. Why, then, are these methods so rarely applied by designers and manufacturers in this country? The reasons are probably two-fold:

(1) Designers have to become accustomed to the extremely thin wall thicknesses used. This is not easy, as the appearance on the drawing board of $\frac{1}{8}$ in. wall thickness in a box section of over 3 ft. square overall dimensions (Fig. 14) will frighten many designers because of a feeling that their jobs will be jeopardised by others ridiculing their capability. Designers are accustomed to use their eyes as much as or more than their slide rules for determining wall thicknesses, etc., and with the experience of existing practice the eye sometimes refuses to approve of the proportions quoted above. Furthermore, it is very hard to be a pioneer when it might mean losing a job, let alone a reputation.

(2) The so-called "plate construction method," which uses simplified shapes cut from plate material with a minimum amount of welding required to complete the structure, produced results which are considered satisfactory (Fig. 11). The increased amount of material preparation required for the light-weight construction methods, together with the additional welding work, often deters designers because the savings in material may be more than cancelled. The proportion of the cost of labour in the total cost of welded structures is apparently much greater in this country than on the Continent, where the wage standard does not seem to be so high as to make the additional cost of labour cancel out the great savings on material obtainable with the "shell" and "cellular" construction methods.

Against these reasons one should, however, consider the ever-growing importance of saving steel, and a few points may be mentioned which may overcome the difficulties stated above. The best way of approach for the designer seems to be that used in so many other branches of engineering, i.e. to obtain by means of small-scale model experiments confirmation of theoretical calculations. The results will not only check the designer's ideas and calculations, but also lead to improvements in the design. The three-legged portal of the crane (Fig. 12) was tested to destruction as a 1/5 scale model (Fig. 13). The actual portal is approximately 30 ft. high and has a span of 25 ft. Failure took place in the model by buckling of the thin walls (Fig. 14), as would be expected. Stiffener webs were inserted at the buckling section (Fig. 15). In comparison with the orthodox method of construction using plate material and rolled sections (Fig. 16), the saving in weight of material was about 30 per cent. It may be mentioned in this connexion that about 40 per cent. of weight was saved by designing the jib as a triangular tubular structure (see also *Welding and Metal Fab.*, Dec., 1951) instead of arranging it in the usual manner as a rectangular structure made from rolled sections.

The equipment for carrying out such scale model experiments may not be easily available at the majority of firms. A suggestion put forward by various people at the Ashorne Hill conference in 1949* may be repeated here, to the effect that research and experimental work on design problems organised on a national scale would considerably assist designers, who for various reasons may be prevented from experimenting with new design ideas in their own limited sphere of activity.

The general problem of labour cost, and in particular that of the welding operations, overshadowing the possible savings of material is a much more difficult one to solve, and this can only be done by close co-operation between designer and production engineer. Reduction in cost of plate preparation and welding in general should not be too difficult, as the thin sheet materials used in the construction methods described lend themselves to guillotine cutting (eliminating flame cutting or machining), bending, and flanging (eliminating corner welds), etc. The cost of the necessary welding operations can also be reduced. Spot welding can be used to advantage where applicable (see Fig. 25). As an example of design arrangements for fusion welding, Griese (1951a) shows for a thin-walled box section (Fig. 17) how a simple flanging operation (Fig. 17b) helps in obtaining a butt weld of full depth equal to

* Conference on "Welding as an Aid to the Saving of Steel and Manpower," organised jointly by the Institute of Welding and the British Welding Research Association, March, 1949.

the sheet thickness, without the need for a sealing run or a backing strip, while at the same time permitting the use of large gauge electrodes with resulting higher welding speeds and smaller distortions. Designers and production engineers should give full consideration to the possibility of applying automatic welding processes to a much greater extent than is at present practiced in this country, even for relatively short runs and small quantities. Large quantities of identical welding runs make the use of automatic welding equipment economical (Griese, 1951b). The designer of welded structures who wishes to apply automatic welding methods can overcome the handicap of small quantities of components by standardising his welded seams, as the designer of machined components uses standardised threads, radii, key ways, etc. Again it is often possible by suitable design arrangements to replace a large number of short seams in different planes and directions by a smaller number of long seams. This will also help towards the economic employment of automatic equipment. In this respect the shell construction method is superior to the use of rolled sections, as can be seen from Figs. 18 and 19. Stresses have to be kept low in the pulley design shown in Fig. 19a, because of stress concentrations which arise at the joints. The smooth shape and the extensive use of butt welds instead of fillet welds in the alternative design (Fig. 19b) reduce such stress concentrations, and the load-carrying capacity of the pulley is then determined by the buckling load of the thin walls. The use of automatic welding is possible for the relatively long runs required in this alternative design, whilst it would not be applicable for the short runs joining the channel-shaped spokes to the hub and the rim.

In conclusion, a few examples illustrate some successful applications of the foregoing design methods. The gear case body (Fig. 20) shows the use of U-shaped stiffeners for thin shells. The heater (Fig. 21), which is built into the cooker body (Fig. 22), has a heating surface of 2,200 sq. ft., an outside diameter of 10 ft., working pressure 60 lb./sq.in. The hollow heater ring sections are built from 0·2 in. sheet material, the walls being stiffened by flats welded in at suitable positions. The winch housing (Fig. 23) has to carry the weight (40 tons) of the column structure (Fig. 24), the force (7 tons) transmitted by a rope and the distorting forces acting through the vehicle. The housing is built of approximately $\frac{1}{4}$ in. thick sheet steel. Its weight is about 12 cwt.

In the machine tool field, the cellular construction of the Diskus grinding machines (Fig. 25) was probably the first of its kind. Fig. 26 shows a "Diskus" surface grinder which is built for a maximum grinding width of 2 ft. and for grinding lengths up to 13 ft., the grinding wheel diameter being 36 in. The weight of such a machine is about 9 tons. For the cellular construction (Fig. 27), steel plates with wall thicknesses from 0·2 to 0·4 in. are employed. The arrangement of the cells can be clearly seen in Fig. 28. On the Continent the cost of manufacture (material plus labour, plus overheads) of welded machine tool structures in cellular construction as described above varies to-day between £100 and £170 per ton according to the complication of the structure. In view of the considerable savings in weight (up to 55 per cent. as compared with similar cast-iron structures) and the lesser need for stress relieving heat treatment in the case of thin walled precision structures, the saving in actual cost will be appreciated, quite apart from the importance of saving weight in general and of steel in particular.

An interesting comparison of the use of the shell (tubular) and cellular construction methods in the design of lathe beds is shown in Fig. 29. As could be expected the tubular construction was found to be slightly more favourable so far as stiffness and rigidity were concerned. The bed in cellular construction showed slight savings in weight which were, however, balanced by the fact that shorter lengths of welded seams were required in the tubular construction.

The examples shown are sufficient to indicate that considerable savings in material are still possible in welded structures in many fields of engineering applications. From an economic point of view it is, of course, essential for designers to bear in mind the danger of losing on the cost of labour what they save on the cost of material. By using their ingenuity and by overcoming certain preconceptions, which are bound to exist in many minds, it ought to be possible, however, to introduce these relatively new methods in our industry and to contribute toward the progress of technically and economically efficient production.

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APPENDIX

Calculations for determining the relation between stiffness K, strength value S (K_b and S_b in bending, K_t and S_t in torsion), cross-sectional area A, depth d and wall thickness t for a freely supported beam of closed box section (see Fig. 3, IV).

The stiffness in bending is (see Fig. 3):

$$K_b = \frac{P}{\delta}$$

$$= \frac{48E}{l^3} \cdot I$$

$$= \frac{48E}{l^3} \cdot \frac{1}{12} \cdot \left[(kd^4 - (kd-2t) \cdot (d-2t)^3 \right]$$

$$= \frac{4E}{l^3} \cdot d^4 \left(6k\frac{t}{d} - 12k\frac{t^2}{d^2} + 8k\frac{t^3}{d^3} + 2\frac{t}{d} - 12\frac{t^2}{d^2} + 24\frac{t^3}{d^3} - 16\frac{t^4}{d^4} \right)$$

In view of the relatively small values used in practice for such box sections, squares, cubes and fourth powers of $\frac{t}{d}$ may be neglected, and then

$$K_b = \frac{4E}{l^3} \cdot d^4 \cdot \left(6k\frac{t}{d} + 2\frac{t}{d} \right)$$

$$= \frac{8E}{l^3} \cdot d^3 t \cdot (3k+1)$$

$$S_b = \frac{P}{f_b}$$

$$= \frac{4I}{l \cdot d/2}$$

$$= \frac{4}{3l} \cdot d^2 t \cdot (3k+1)$$

The stiffness in torsion (K_t) can be determined by the ratio between torque (T) and angle of twist (θ), where

$$\theta = \frac{Tl \cdot (2d + 2kd - 4t)}{4A_m^2 \, Ct}$$

and the mean area $A_m = (d-t) \cdot (kd-t)$. Again neglecting squares, etc., of $\frac{t}{d}$

$$K_t = \frac{T}{\theta} = \frac{2C}{l} \cdot d^3 t \cdot \frac{k^2}{k+1}$$

In a similar manner

$$f_{\text{torsion}} = \frac{T}{2A_m \cdot t}$$

and $S_t = \frac{T}{f_{\text{torsion}}} = 2t \cdot (d-t) \cdot (kd-t)$,

which simplifies to

$$S_t = 2kd^2 t.$$

For convenience in making calculations a unit length is desirable, and in this case 36 in. seems to be appropriate.* Then

* The actual values for different lengths may be obtained by dividing equation (1) by $\left(\frac{l}{36}\right)^3$ (2) by $\left(\frac{l}{36}\right)$, (3) by $\frac{l}{36}$. Equation (4) is unchanged as the length does not affect the torsional stress in the section.

$$K_b = \frac{8}{36^3} \cdot Ed^3t \cdot (3k+1) = 0{\cdot}00017\ Ed^3t(3k+1) \quad .. \quad (1)$$

$$S_b = \frac{4}{3 \times 36} \cdot d^2t \cdot (3k+1) = 0{\cdot}037\ d^2t \cdot (3k+1) \quad .. \quad .. \quad (2)$$

$$K_t = \frac{2}{36} \cdot C \cdot d^3t \cdot \frac{k^2}{k+1} = 0{\cdot}056\ C \cdot d^3t \cdot \frac{k^2}{k+1} \quad .. \quad .. \quad (3)$$

$$S_t = 2d^2t \cdot k \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (4)$$

The weight of material required to obtain a specified value of stiffness or strength at a specified length depends upon the cross-sectional area A of the section. In order to find the relation between K, S, A, d and t equations (1) to (4) may be rewritten as follows:

For the closed box section IV as shown in Fig. 3—

$A = kd^2 - (d-2t) \cdot (kd-2t)$, which on neglecting squares reduces to

$$A = 2dt\ (k+1),$$

and by substitution in equations (1) to (4)

$$A = \frac{11700}{E} \cdot K_b \cdot \frac{1}{d^2} \cdot \frac{k+1}{3k+1} \quad .. \quad .. \quad .. \quad .. \quad (5)$$

$$A = 54 \cdot S_b \cdot \frac{1}{d} \cdot \frac{k+1}{3k+1} \quad .. \quad .. \quad .. \quad .. \quad (6)$$

$$A = \frac{36}{C} \cdot K_t \cdot \frac{1}{d^2} \cdot \frac{(k+1)^2}{k^2} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (7)$$

$$A = S_t \cdot \frac{1}{d} \cdot \frac{k+1}{k} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (8)$$

It follows that, as the depth of the section increases, for specified values of K the cross-sectional area, and with it the weight of material in the beam, decreases in proportion to d^2, and for specified values of S in proportion to d.

The wall thickness t may also be written

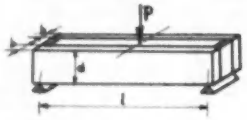
$$t = \frac{A}{2d} \cdot \frac{1}{k+1} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (9)$$

$$t = \frac{5850}{E} \cdot K_b \cdot \frac{1}{d^3} \cdot \frac{1}{3k+1} \quad .. \quad .. \quad .. \quad (10)$$

$$t = 27 \cdot S_b \cdot \frac{1}{d^2} \cdot \frac{1}{3k+1} \quad .. \quad .. \quad .. \quad (11)$$

$$t = \frac{18}{C} \cdot K_t \cdot \frac{1}{d^3} \cdot \frac{k+1}{k^2} \quad .. \quad .. \quad .. \quad .. \quad (12)$$

$$t = \frac{1}{2} \cdot S_t \cdot \frac{1}{d^2} \cdot \frac{1}{k} \quad .. \quad .. \quad .. \quad .. \quad (13)$$



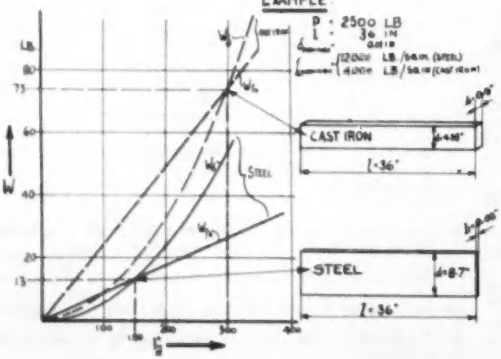


Fig. 1.

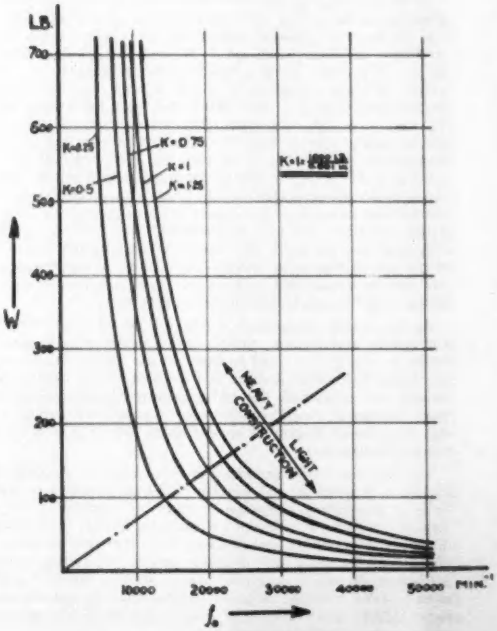
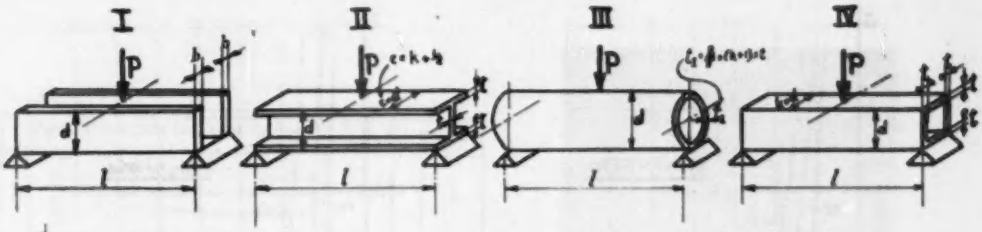


Fig. 2.



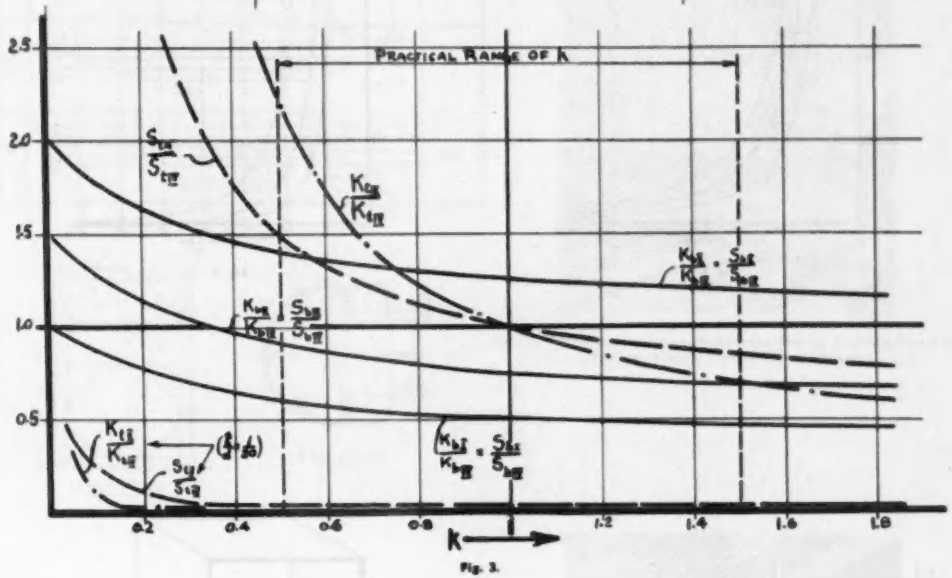


Fig. 3.

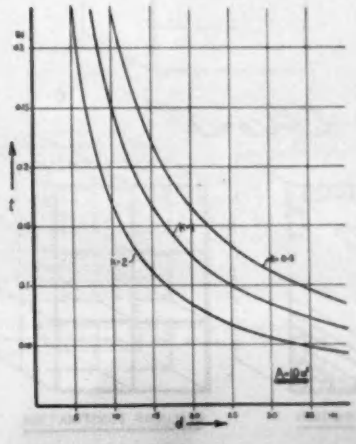


Fig. 4.

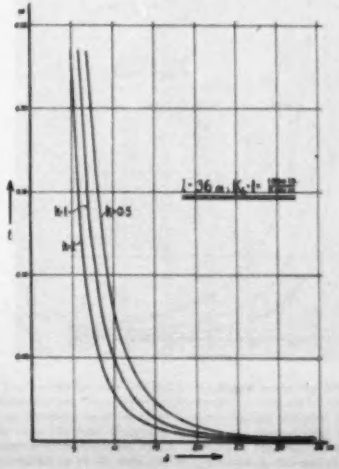


Fig. 5.

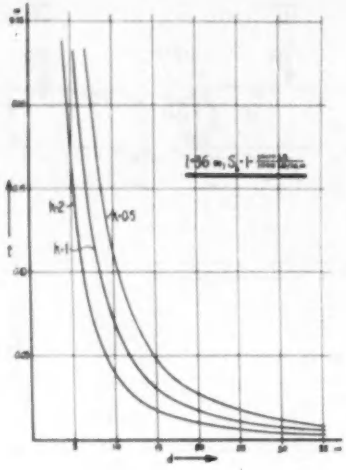


Fig. 6.

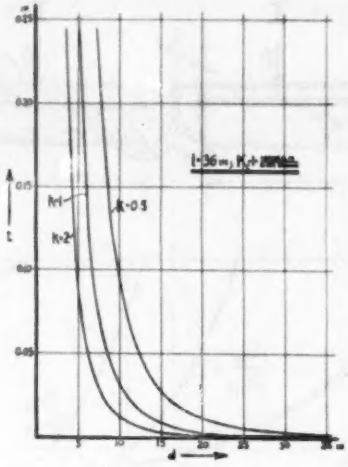


Fig. 7.

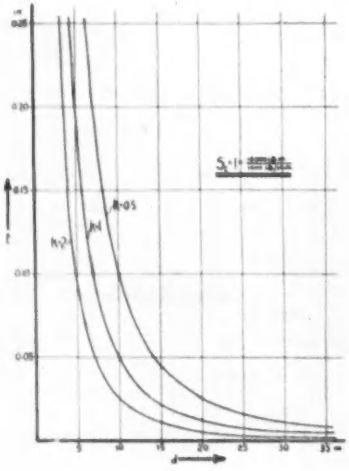


Fig. 8.

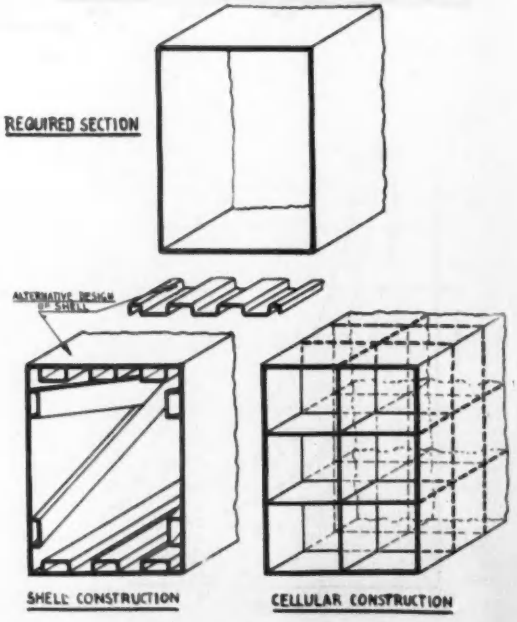
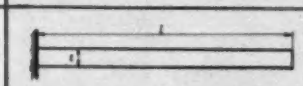
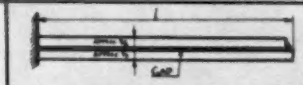


Fig. 9.

	CANTILEVERS OF EQUAL TOTAL CROSS SECTION	TYPE OF CONSTRUCTION	DAMPING CAPACITY
I		SOLID	1
II		FILLET WELDED GAP BETWEEN PLATES	1
III		BUTT WELDED BENDING OF PLATES BEFORE WELDING, AND STRESSED TO SUBSEQUENT DEFORMATION RESULTS IN FOLDING AND NO GAP	64

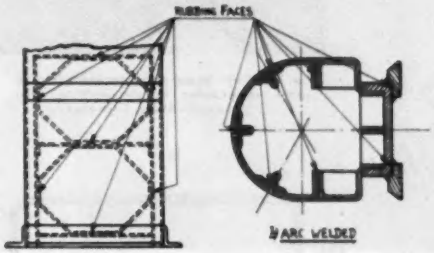


Fig. 10.

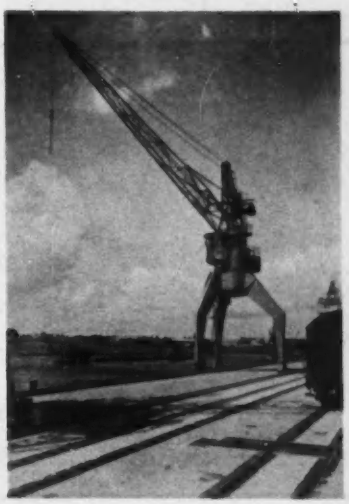


Fig. 12. Three leg portal dockside jib crane (Demag, Duisburg, Germany). Loading capacity, 3 tons at 60 foot outreach

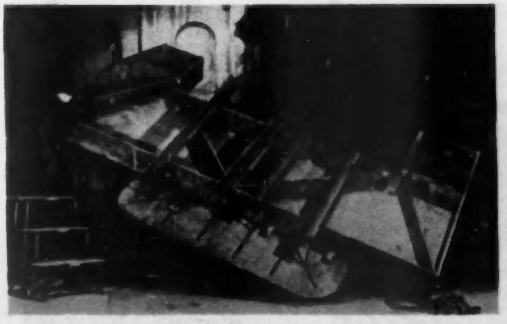


Fig. 11. C-shaped frame in "plate" construction for hydraulic straightening press during manufacture at the works of Cooke & Ferguson Ltd., Manchester.

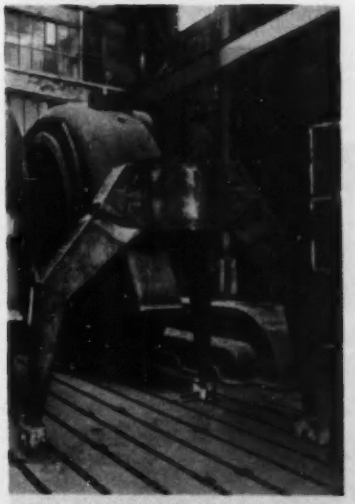
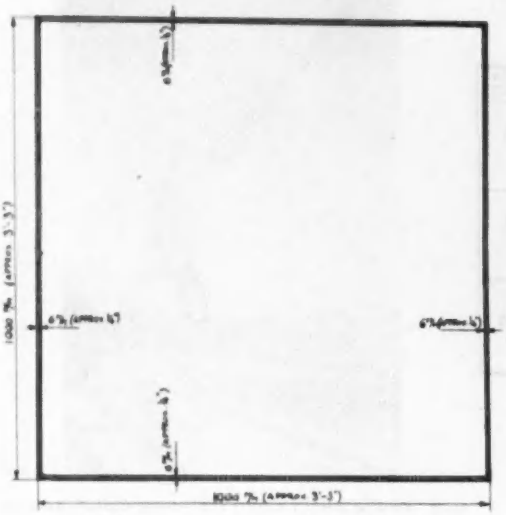


Fig. 13. Test model (scale 1—5) of three legged portal for crane (Fig. 12). "Shell" construction. Wall thickness of model box section 1·2 mm. (= $\frac{1}{20}$ in.). Collapse by buckling under load of 9½ tons, applied 110 mm. (=4½) eccentrically to axis. The wall thickness of the actual portal (Fig. 15) is 6 mm. The collapsing load would be $9\frac{1}{2} \times 5^2 = 240$ tons. Maximum load on actual portal estimated to be 40 tons. (Demag, Duisburg, Germany)



CROSS SECTION OF LEG FOR PORTAL CRANE (FIG 12) AT CRITICAL SECTION (SEE FIG 13)

Fig. 11.

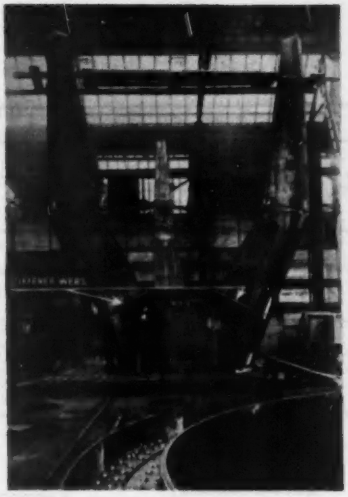


Fig. 13. Three legged portal for crane (Fig. 12) under construction in the welding shop. (Demag, Duisburg, Germany)

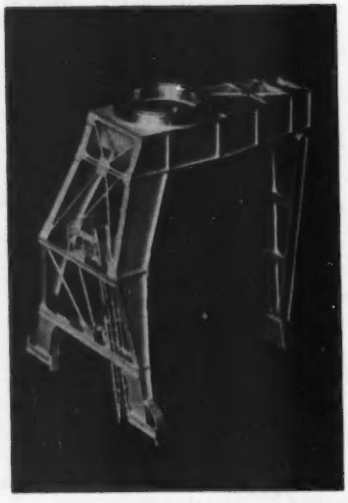


Fig. 16. Older welded design of three legged portal (model). (Demag, Duisburg, Germany)

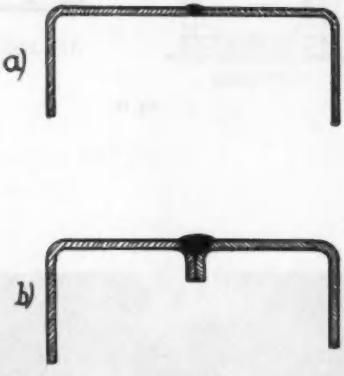


Fig. 17

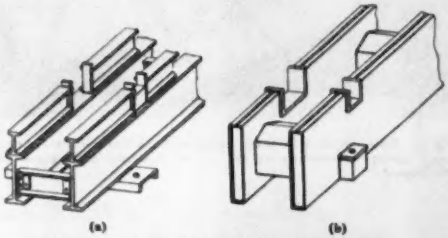


Fig. 18. Frame for Large Rolls (from Grisse, Schweissen und Schneiden, 1951, Sonderheft).
(a) Built from rolled sections. (b) Shell construction.

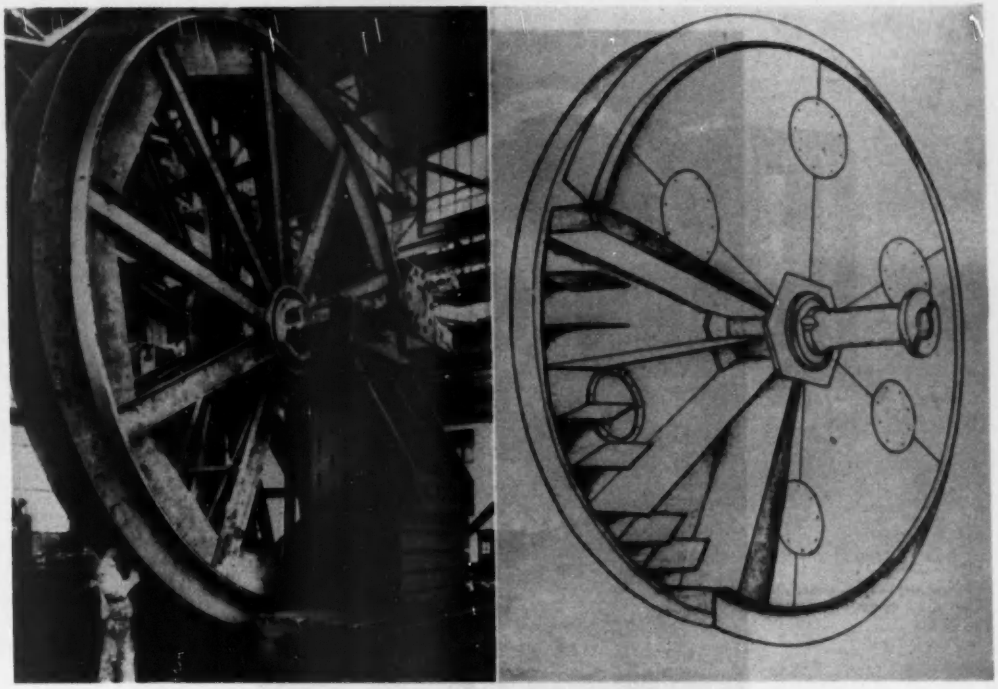


Fig. 19. Pulley for mining machinery (Demag, Duisburg, Germany).

(a) Construction using rolled sections (b) Schematic sketch of shell construction

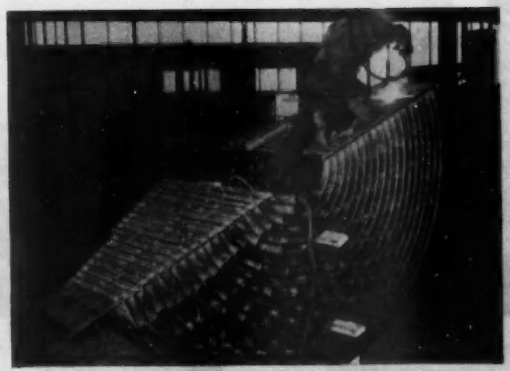


Fig. 21. Heater for chemical plant (Salzgitter Maschinen A.G., Germany)

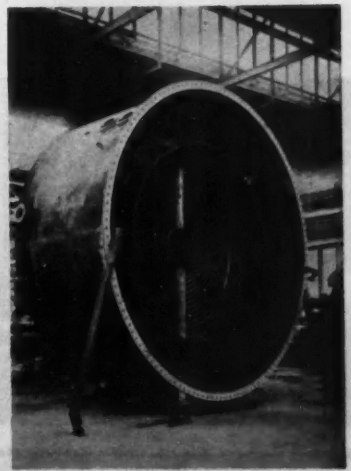


Fig. 22. Cooker Body (Salzgitter Maschinen A.G., Germany)

Fig. 20. Gear box in shell construction. (Demag, Duisburg, Germany)

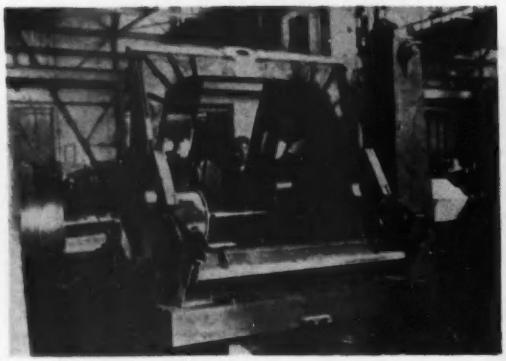


Fig. 23 Winch housing in light construction (Salzgitter Maschinen A.G., Germany)

Fig. 24. Vehicle incorporating the winch housing (Fig. 23). (Salzgitter Maschinen A.G., Germany)

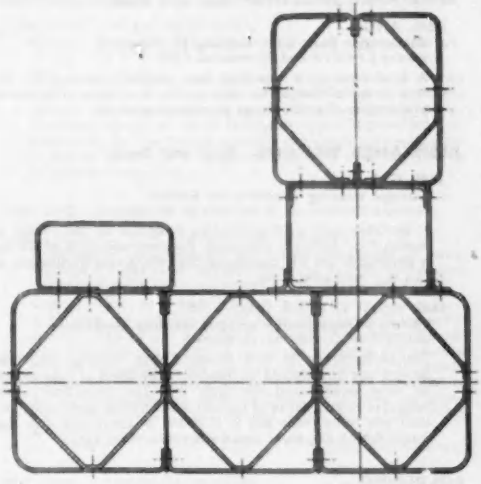


Fig. 25. "Diskus" Cellular Construction

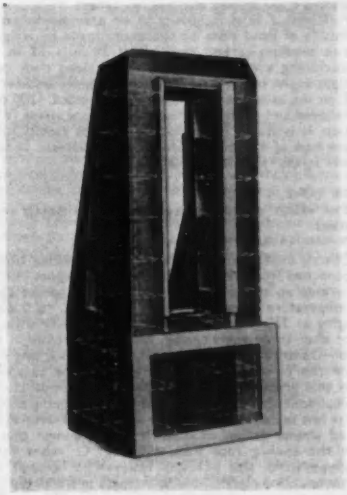
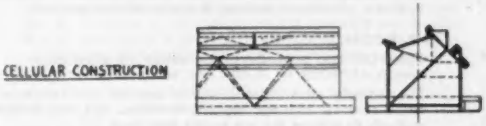


Fig. 27. Upright for surface grinding machine (Fig. 26) with cells sketched into the photograph



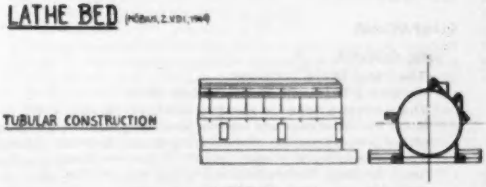


Fig. 29

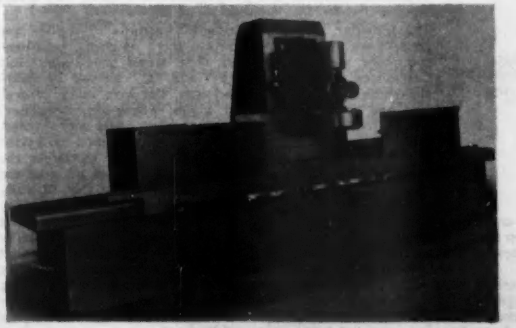


Fig. 26. Large surface grinding machine (Diskus, Frankfurt a.M., Germany)

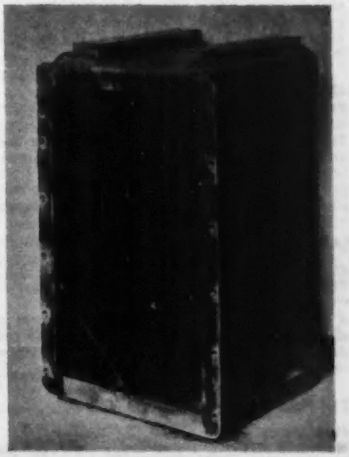


Fig. 28. Body for a small grinding machine (plate thickness approx. 0·15 inches) (Diskus, Frankfurt a.M., Germany)

ABSTRACTS—(*continued from page* 112)

1639. DEGARMO, E. P.

Preheat vs. low- and high-temperature stress-relief treatments

Welding J., vol. 31, 1952, May suppl., pp. 233-237

Following a brief introduction on previous investigations, the results of bend tests on specimens made by welding together two medium carbon steel plates 30 in. × 18 in. × ¾ in. and machining a v-notch 0·025 in. deep along their centre line at right angles to the weld are given. They were tested at —80 deg. F. in the as-welded, 400 deg. F. pre-heated, 1200 deg. F. stress relieved and controlled low temperature stress relieved condition. It is stated in conclusion that the results indicate that a pre-heat of 400 deg. F. produces a weldment as satisfactory as one stress relieved at 1200 deg. F.

1640. LOW, J. R.

The effect of quench-ageing on the notch sensitivity of steel

Welding J., vol. 31, 1952, May suppl., pp. 253-256

Charpy impact test specimens of a semi-killed 1020 steel were quenched from 690 deg. C. and aged at room temperature for periods up to three years. During this period the transition temperature increased from —40 deg. C. to 0 deg. C. Over-ageing at 350 deg. C., either immediately following quenching or after three years ageing, lowers the transition temperature to —15 deg. C. It is suggested that quench-ageing is responsible for the commonly observed brittle zone adjacent to welds in this grade of steel and that a low-temperature post-heat treatment similar to that used for over-ageing should improve the low temperature ductility of welded structures made of this and similar grades of steel. It is also shown that a decrease in the cooling rate from 690 deg. C. raises the transition temperature; this effect is believed to account for the fact that as-rolled plates show an increase in transition temperature as the thickness increases. (Author's Abstract.)

1641. SMITH, D. C. and RINEHART, W. G.

Heat treating properties of low hydrogen electrode weld metals.

Welding J., vol. 31, 1952, April, pp. 296-305

It is necessary to know the effect of heat treatment on weld metals when selecting an electrode for welding alloy steels which have to be heat treated after fabrication to obtain the best performance from the weldment. This article deals with the results of a series of tensile, hardness, impact and Jominy hardness tests made on specimens subjected to certain heat treatment procedures and deposited by eight low hydrogen electrodes of different alloy content. The results are presented in graphical form.

1642. TESMEN, A. B.

Preheating for welding

Welding J., vol. 31, 1952, April, pp. 306-313

The effect of preheating on the structure and mechanical properties of the welded joint is reviewed and it is shown how this treatment minimizes the danger of cracking. A chart summarizing recommended preheat temperatures is given and the various heating methods are briefly described.

METAL SPRAYING

1643. KELLER, F.

The metallizing process

Welding J., vol. 31, 1952, April, pp. 291-295

A brief article dealing with the development of the metal spraying process, its application to reclamation and protection, the preparation of the surface by various methods and the nature of the coating.

OXYGEN

1644. BRINLEY, J. F.

New million dollar liquid oxygen/nitrogen plant

Welding J., vol. 31, 1952, June, pp. 495-499

The production of oxygen, nitrogen and argon is outlined and details of the plant are given. In addition to supplying oxygen in cylinders, considerable quantities are conveyed to large works by a 3-in. pipe line working at 100 lb. per sq.in. pressure. A fleet of vehicles for transporting liquid oxygen is nearly complete. These will either supply the user with liquid oxygen or will charge up his storage cylinders with dry gas, thus eliminating the task of returning them to the supplier for re-charging.

RESISTANCE WELDING.—Butt and Flash

1645. ANON.

Automatic flash butt welding in shipyards

Welding & Metal Fab., vol. 20, 1952, July, p. 241

A brief note on a new flash butt welding machine for the attachment of flanges to pipes up to 8 in. bore. No special preparation of either flange or pipe is required.

RESISTANCE WELDING.—Spot and Seam

1646. GEE, C. C.

Garage welding modern car bodies

Welding & Metal Fab., vol. 20, 1952, July, pp. 262-263

A portable spot welding machine designed for the repair of damaged car bodies is described. An electrode force of 200 lb. is obtainable and the capacity of the unit is two thicknesses of 16 s.w.g. mild steel sheet.

1647. HOLT, E. F. and SINK, L. W.

Effects of nose design on spot welding electrodes

Welding J., vol. 31, 1952, May, pp. 400-406

The performance of nine standard spot welding electrode designs was investigated to determine the effect of nose design on weld quality and electrode life. The electrodes were subjected to two series of tests in which 10,000 spot welds per electrode were made and it is stated in conclusion that the results favour the blunt nosed and radius faced types.

SOLDERING

1648. ANON.

Stainless gutters, downspouts easily fabricated

Iron Age, vol. 169, 1952, June 12, pp. 126-127

Straight chromium stainless steel is gaining favour as a material for guttering, downspouts, etc., and is easily joined by soldering if certain procedures outlined in this article are adopted.

1649. BIRDSALL, G. W.

Materials and procedures for soldering aluminium

Materials and Methods, vol. 35, 1952, April, pp. 116-118

The successful soldering of aluminium depends upon satisfactory oxide removal and the use of ultrasonic, flux and friction methods to achieve this are briefly described.

SURFACING

1650. COOPER, J. A.

The "Dot Weld" process

Welding & Metal Fab., vol. 20, 1952, June, pp. 218-219

This process is used for salvaging defective castings where the faults are blowholes and surface imperfections. The principle of this process consists of a vibrating electrode which deposits a dot of weld metal at each contact. This is immediately cooled by an air blast. Electrodes are available for welding cast iron, malleable iron, steel, aluminium and its alloys and copper and its alloys, and in the case of cast iron, no hard zones are formed.

TESTING.—Cracking

1651. RIEPPEL, P. J. and VOLDRICH, C. B.

Fracture initiation and propagation in welded ship steels

Welding J., vol. 31, 1952, April suppl., pp. 188-197

The initiation and propagation of fractures in welded and prime-plate Kinzel-type transversely notched bead-bend specimens were investigated. The steels used were Ship Committee Project Steels "B_1" and "C" welded by E6010 electrodes. In all welded specimens, the weld metal cracked first and at very low bend angles. Prime-plate specimens cracked only after a much greater bend angle was reached. The difference in the amounts of energy absorbed by welded and prime-plate specimens was found to be chiefly in the difference in energy absorbed by the specimens prior to the initiation of cracks. Results of this work and that of many previously reported investigations show that cracks are very likely to initiate in weld metal transverse to weld joints that are strained plastically in the longitudinal direction. Cracks from such origin may be the starting points of many structural failures. Results suggest that the data from many welded test specimens be re-examined in light of data presented in this paper. It seems likely that poor performance, which has been believed to be caused by heat-affected zones, may in reality be directly related to weld-metal performance.

(Authors' Abstract.)

TESTING.—Fatigue

1652. HOLT, M. and HARTMANN, E. C.
Fatigue tests on aluminium alloy spot-welded joints
Welding J., vol. 31, 1952, April supp., pp. 183-187

The results of fatigue tests on single spot lap joints in various high strength aluminium alloys are presented. The results indicate that fatigue strength is not related to static strength. Artificial ageing of joints fproduces little improvement in properties and the fatigue strength of a single spot weld joint is inferior to that of a lap joint made with a single rivet of equivalent dimensions.

TESTING.—Impact

1653. GEIL, G. W., CARWILE, N. L. and DIGGES, T. G.
Influence of nitrogen on the notch toughness of heat-treated 0·3 per cent. carbon steels at low temperatures
J. of Research of Nat. Bureau of Standards, vol. 48, 1952, Mar., pp. 193-200

Charpy impact tests were made at temperatures ranging from —196 deg. to 100 deg. C. on fully hardened and tempered specimens of 0·3 per cent. carbon steels with variable nitrogen. The transition from ductile to brittle fractures was affected by both the amount and form of the nitrogen in the steels. Fixation of the nitrogen as aluminium nitride was beneficial, as the aluminium-treated steels had considerably lower transition temperatures than those of the steels not treated with aluminium.

(Authors' Abstract.)

TESTING.—Ultrasonic Methods

1654. GREENBERG, H.
Ultrasonic inspection checks quality of brazed joints
Materials and Methods, vol. 35, 1952, June, pp. 102-105

Describes the application of the Reflectogage to the inspection of a brazed contact assembly. By comparing the patterns generated on the screen of a cathode-ray tube by a solid copper bar of the same overall length as the assembly and by the brazed assembly it is possible to assess accurately the quality of the joints and to obtain good correlation between ultrasonic and shear tests.

WELDABILITY.—Effects of Hydrogen

1655. SCHAEFFLER, A. L., CAMPBELL, H. C. and THIELSCH, H.
Hydrogen in mild steel weld metal
Welding J., vol. 31, 1952, June supp., pp. 283-309

Hydrogen embrittlement may occur in mild steel weld deposits made by the covered electrode process as a result of moisture or hydrogen producing compounds in the coating, the contents of the surrounding atmosphere or hydrogen present in the base metal. This article is a review of published and unpublished information on this subject and deals with the effect of this phenomenon on the mechanical properties of the deposit and welding considerations, and its relationship to various defects such as porosity, cracking and "fish-eyes." There is a bibliography of 183 references.

WELDABILITY.—Ferrous.—Cast Steel

1656. ANON.
Recommended practice for the welding of steel castings.
Welding J., vol. 31, 1952, April, pp. 315-322

Recommended procedures for the production of sound crack-free welds in steel castings by the metallic arc process are given and the joint preparation for the repair of castings and joining of two separate castings to form a composite structure is noted. Defects, such as hot and cold cracking, permanent deformation and porosity, may occur as a result of welding and means of eliminating these by preheating and special welding techniques are described. Residual stresses and quench hardness will be removed when the casting receives its final heat treatment.

WELDABILITY.—Ferrous.—Heat Resistant Alloys

1657. ROSENBERG, A. J.
Welding characteristics of materials for aircraft gas turbines
Welding J., vol. 31, 1952, May, pp. 407-413

This article describes the results obtained from a development programme initiated to determine the weldability of austenitic stainless steels, nickel alloys, high temperature alloys of the Stellite type, low alloy steels and titanium, welded by the metallic arc, inert-gas-shielded arc, atomic hydrogen and resistance processes.

WELDED CONSTRUCTION.—Agricultural Machinery

1658. ANON.
Production of mechanized farm equipment
Welding & Metal Fab., vol. 20, 1952, June, pp. 196-202

The great demand for farm equipment has necessitated the application of quantity production methods to its manufacture. This article describes the production of various pieces of agricultural machinery and makes particular reference to the jigging equipment employed.

WELDED CONSTRUCTION.—Pipes

1659. ANON.
Hot bending large diameter pipes on site
Welding & Metal Fab., vol. 20, 1952, July, pp. 246-247

In the bending method described the pipe is filled with sand, the ends closed, heated to red heat in a portable furnace and removed to the bending table where one end is clamped in a special fixture and the other is attached to a capstan. As the capstan pulls round the free end the inside radius of the pipe is quenched to prevent wrinkling and any defects of this nature which do occur are finally dressed out when the pipe has cooled.

1660. BURT, F. M.
Tricky welding for pipe system
Welding Eng., vol. 37, 1952, May, pp. 37-39

Describes briefly the fabrication of type 304 ELC stainless steel pipe from 16 in. to 36 in. diameter by the inert-gas-shielded arc process. The material was flame cut by the flux injection process and the special testing technique necessitated by the absence of flanges is outlined.

1661. SCOTT, P. A.
A 75-inch-diameter water main in tunnel: A new method of tunnelling in London clay
Proc. Inst. Civil Engs., vol. 1, 1952, May, pp. 302-317

The author describes the construction of an experimental pipe line for water supply purposes in which all the welding is carried out from the inside.

1662. TUCKER, A. J. P.
High quality pipe butt welding without backing strips
Welding & Metal Fab., vol. 20, 1952, July, pp. 253-257

This article describes a method of making fusion butt welds in mild steel piping by a metal arc process which allows good control of root penetration. No backing strips are needed and penetration is controlled by careful establishment of electrode size, welding current, weld preparation and movement of the electrode tip during the deposition of the root run. Methods of testing the welds and uses of the process are discussed. Applications of the argonarc process to the welding of piping of the 18 per cent. chromium-8 per cent. nickel, and the 3 per cent chromium-molybdenum types are also described. It is shown that for these materials argonarc welding has several advantages over metal arc welding. (Author's Abstract.)

WELDED CONSTRUCTION.—Pressure Vessels

1663. ANON.
Fabricating modern pressure vessels
Welding & Metal Fab., vol. 20, 1952, June, pp. 207-212

In this article, some of the factors influencing the design of pressure vessels are considered. The materials used in their construction and the special techniques required when welding low and high alloy steels and clad steels are described.

WELDED CONSTRUCTION.—Railway Rolling Stock

1664. ANON.
Rolling-stock construction at Eastleigh
Welding & Metal Fab., vol. 20, 1952, July, pp. 236-240

The production of steel carriage bodies for the steam and electric systems at the British Railways Eastleigh Carriage Works is described. The article is illustrated by photographs of the fabricating and welding equipment in use. Reference is made to the "puddle" process for attaching the carriage roofs to the roof members.

1665. WALDRON, W. D.
Oxy-acetylene welding and cutting as applied to railroads
Welding J., vol. 31, 1952, June, pp. 486-491

The author deals with the application of oxy-acetylene welding and cutting to the repair and fabrication of parts for carriages, wagons, steam and diesel locomotives.

WELDED CONSTRUCTION.—Repairs

1666. COULTHARD, J. W.
Welding in ship repairs
Trans. Inst. Mar. Engs., vol. 64, 1952, April, pp. 2-5, May, pp. 1-5
In part 1, the author deals in a practical manner with the repair of both riveted and welded ships, including repairs to shell plating, stern frames and boilers. In the second part, the cost of shop and on-board ship repair work is compared and weldability, with particular reference to the repair of a steel casting, is discussed. Underwater welding and the repair of iron castings are outlined.

WELDED CONSTRUCTION.—Ships

1667. ANON.
M.L. "Queen Elizabeth"
Welding & Metal Fab., vol. 20, 1952, June, pp. 228-229
Describes briefly how the Aircomatic process was applied to the fabrication of the superstructure of a pleasure launch in this country.

1668. ANSELL, E. W.
Factors involved in welded shipbuilding
Welding & Metal Fab., vol. 20, 1952, June, pp. 213-218
The author outlines the advantages of welded construction and shows how the introduction of welding has affected the position of shipyard machinery. The relative merits of A.C. and D.C. supply are considered and a suggested welding shop layout is given. The importance of a planned erection sequence for prefabricated units and final assembly is explained and the necessity for good supervision emphasised. Radiographic inspection has proved satisfactory in maintaining weld quality and it is stated in conclusion that the future of welded shipbuilding is assured.

1669. VENUS, J.
Marine developments in aluminium
Trans. Inst. Eng. & Shipbuilders in Scotland, vol. 95, 1951-52, Part 1, pp. 23-47, Discussion, pp. 47-48, Part 2, pp. 49-63
The successful use of aluminium in the construction of various types of vessel is described and details of research undertaken to date are given. The relationship between the British Standard Specifications and other specifications is noted and factors which affect the economic use of aluminium are discussed. Finally the methods for the fabrication of this material are given and considerable space is devoted to welding.

WELDED CONSTRUCTION.—Stress Analysis

1670. KOENIGSBERGER, F.
Design stresses in fillet weld connexions
Proc. Inst. Mech. Engs., vol. 165, 1951, pp. 148-157
Excessively high factors of safety have frequently resulted in the design of fillet weld connexions which were uneconomical. The author describes a method of determining the collapse load of eccentrically loaded connexions by an investigation of the stresses in the plastic state prevailing immediately before failure. From this the working load is obtained by dividing the collapse load by a suitable factor. Results in close agreement with those calculated by the method given in the paper are found from practical experiments.

1671. WILLIAMS, D.
Load distribution in riveted and spot-welded joints
Proc. Inst. Mech. Engs., vol. 165, 1951, pp. 141-147
A recent test on identical boxes of spot welded and riveted construction showed that the spot welded box failed at about 2/3 the failing load of the riveted box, although the shear strength of a spot weld is nearly twice that of an equivalent rivet. The author examines load distribution theoretically on the basis of stress-strain curves for both types of fastening obtained experimentally and the problem is investigated in both the elastic and plastic ranges of the curves.

WELDED CONSTRUCTION.—Tubing

1672. ANON.
Continuous tube forming and welding
Welding & Metal Fab., vol. 20, 1952, June, pp. 204-206
Describes a continuous tube forming machine recently completed in this country for a firm in Brazil and capable of producing 120 ft. of tube per minute in diameters from ¼ in. to 2½ in. The welding is carried out by a specially designed oxyacetylene welding unit.

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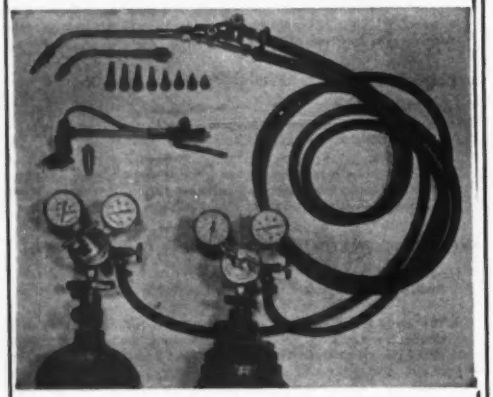

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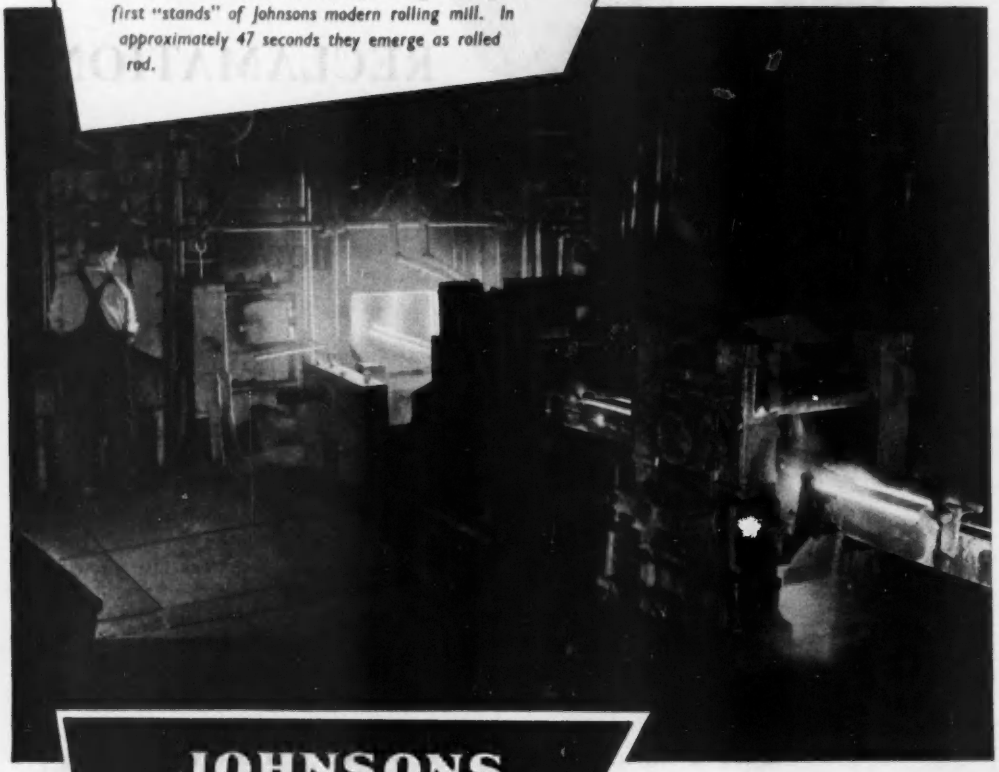

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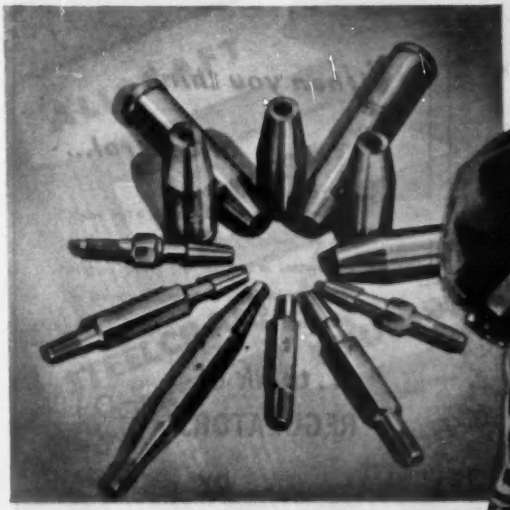

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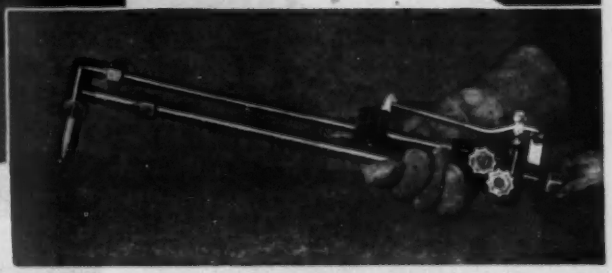

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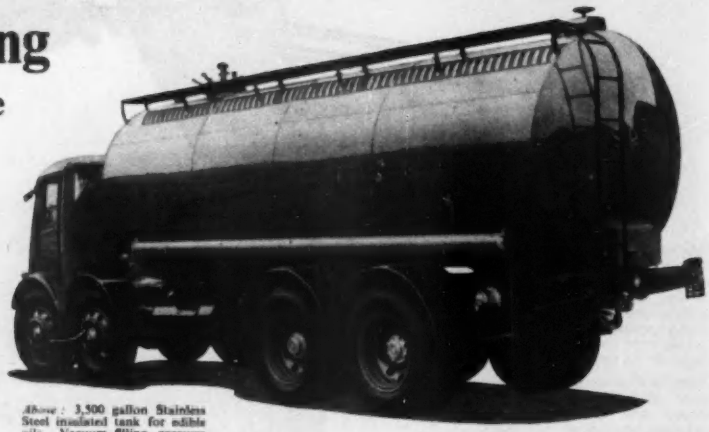

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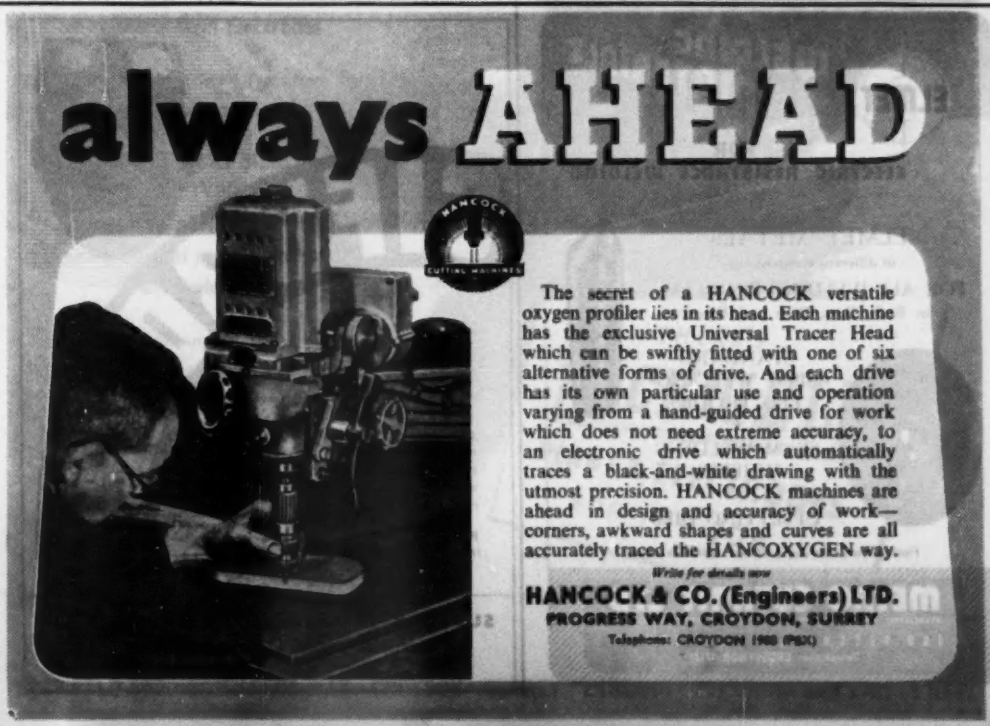
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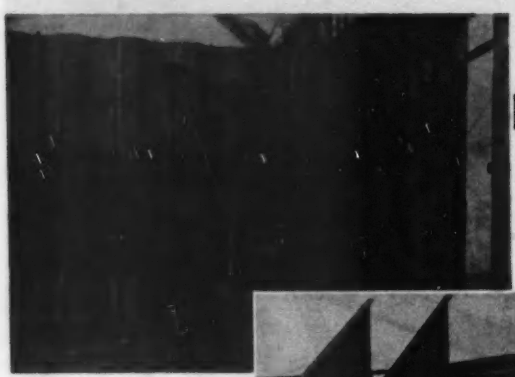

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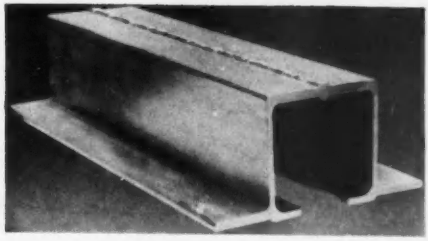
The electrodes are of the plain extruded type and have the advantages of uniformity of coating and welding properties. They are smooth running, simple to use and while they are designed for downhand welding, they can also be used in all positions. Another feature is that the slag is easy to remove.

The electrodes are officially approved by the Ministry of Supply for welding military bridging equipment and they represent the latest advance in the arc welding of aluminium alloys.



An aluminium alloy section of ⅜ in. thickness welded with one run and a sealing run, using a No. 4 gauge Murex extruded aluminium silicon electrode without special edge preparation and without preheating.

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- ★ *Aluminium alloys of thicknesses up to ⅜ in. can be welded without special edge preparation and without preheating.*
- ★ *Plain extruded type of electrode for uniformity of coating and welding properties.*
- ★ *Smooth running—simple to use—primarily a downhand electrode but can be used in all positions. Easy slag removal.*

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